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A STUDY OF MAGAZINE AND NEWSPAPER SCIENCE ARTICLES WITH RELATION TO COURSES IN SCIENCES FOR HIGH SCHOOLS.[1]

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The job of making courses of study is not so simple as it seems. The more one works in this field, the more complex the problem becomes. Before purchasing a suit of clothes, a watch, or a life insurance policy, it is customary for a person to have in mind certain standards which will guide in the selection. We must do the same thing in the case of a course of study. Before incorporating subject matter, we must set up certain principles or standards which will aid in sifting material. To secure any large number of subject-matter specialists and educators to agree upon such principles is exceedingly difficult. It is very much more difficult to secure an agreement as to the application of the principles in the evaluation of subject matter, especially where a liberal interpretation would mean the relegating of certain content of long standing to the graveyard and the substitution of other materials more in harmony with the principles set up. It is not the purpose of this paper to present a discussion of the controversy between the conservatives and the liberals in relation to principles; neither will it enter into the arguments for the literal or implied application of the principles, once they are established. It is worth recalling that in relation to the life of their times, the disciples of Christ were radicals, and without the theory of implied powers in the constitution as interpreted by Chief Justice Marshall, it is exceedingly doubtful whether our infant government would have passed safely through the diseases of childhood to emerge a full-grown man.

A major assumption upon which this investigation rests is that subject matter should enable pupils to perform better those de-

[1]The writer is greatly indebted to his 1924 Denver extension class in Curriculum Making II for aid in carrying on this investigation.

sirable activities in which they are now engaged. In order to apply such a principle, we must first find out what activities pupils are engaging in on any grade level; second, select those which are desirable; third, make an activity analysis of these to determine what is actually being done and discover the content which will make for greater efficiency; and fourth, see that this content is taught in some course of study which may be organized either on the subject or the activity basis.

In the city of Denver, Colorado, where this investigation was carried on, it was found that reading the daily newspapers and weekly or monthly magazines was one of the major activities of junior and senior high-school pupils. The assumption was made that this was a desirable activity, and that it was the business of the school to make the pupils more efficient in performing it. Therefore the purpose of this study was to see what scientific information a person needed to know in order to read intelligently the daily newspapers and a selected list of magazines.

It is very apparent that in attacking this problem, the first step was to discover what newspapers and magazines were read. With the former, this was exceedingly simple as there were four newspapers published in the city. These were the Rocky Mountain News, Denver Times, Denver Express, and Denver Post. With the latter, the information was obtained in three ways; first, asking the pupils what they read; second, examining magazine subscription lists to see what went into the homes of junior and senior high-school pupils; and third, checking the magazine sales of public newsstands. As a result of this survey the following magazines were selected for analysis:

Purely scientific	Popular Mechanics Scientific American
Home Magazines	Ladies' Home Journal Good Housekeeping
Weeklies	Saturday Evening Post Literary Digest
Farm Publications	Country Gentleman Farm Journal

A month's issue of the newspapers including four Sunday editions was examined. The dates were from February 15 to March 15, 1924. Six numbers of each monthly magazine for 1923 were selected. In order that the four seasons of the year be represented, the February, April, June, August, October and December numbers were analyzed. In the case of the weeklies, the second issue for these same months was used.

The papers and magazines were read for articles of a scientific nature. Each article was clipped, labelled with the name and date of publication, and then placed in a separate envelope marked with the title of the article and a brief summary of the contents. After this step was completed, the articles were re-read and classified according to certain branches of science. Those originally selected were biology, chemistry and physics inasmuch as these are the three most common science courses offered in secondary schools. It was soon found, however, that this classification was not broad enough and that other branches of science and its related material would have to be added or articles discarded. The final list included the three mentioned above plus astronomy, biography, geology, and psychology.

Inasmuch as the size of type, width of columns, and the spacing between words varied in the different newspapers and magazines, it was found necessary to reduce this to some constant measure. This was done by accepting the regular column in the Rocky Mountain News as the standard of measurement, and multiplying the number of row inches in all other newspapers and magazines by a constant factor in order to procure the corrected number of inches. In measuring the articles for the number of inches, only that part which was devoted to the scientific principle or its application was included, the remaining filler being eliminated.

All of the clippings in each of the branches of science were read a third time in order they that might be classified into smaller subdivisions. Two main headings were selected. The first was called theoretical and was designed to cover items dealing entirely with the soundness or justification of theoretical principles. The second was designated as applied and included those items where theory was discussed for the purpose of explaining one or more of its practical working applications. Under each of these general headings further subdivisions were made. In the final result theoretical physics, for example, was broken up into the subdivisions of heat, light, mechanics, and sound, while applied chemistry had the following: general interest, household processes, shop processes, alcohols, fertilizers, metals, health.

Each article in each science subdivision was read a fourth time and the major science content noted. This process has not yet been completed. The frequency of occurrence of each item will be secured, the result of which ought to give a list of facts

and principles which pupils should understand in order to interpret better the scientific aspects of their ordinary readings.

First of all there were 2,770 articles covering 32,660 inches of space which were clipped and read. Of these, 532, covering 3,971 inches, were taken from the newspapers while 2,238, covering 28,689 inches, were taken from the magazines. In the case of the newspapers 60 per cent of the articles, covering 63 per cent of the space, were given to biology; 17 per cent of the articles or 15 per cent of the space to physics, and 2 per cent of the articles covering approximately half that amount of space to chemistry. The remaining articles and space were divided up among astronomy, biography, geology, and psychology. In the case of the magazines 16 per cent of the articles or 27 per cent of the space was given to biology, 73 per cent of the articles and 52 per cent of the space to physics, 5 per cent of both the articles and space to chemistry, the remaining articles and space being distributed among the other sciences. Furthermore in the case of both physics and chemistry less than 3 per cent of either articles or space was classified under the theory of the science. A summary of these results in shown in Table I.

TABLE I

Subject	Newspaper				Magazines			
	Number of Articles	Number of Inches	Per Cent of Articles	Per Cent of Inches	Number of Articles	Number of Inches	Per Cent of Articles	Per Cent of Inches
Astronomy	7	135	1.3	3.4	26	543	1.2	1.9
Biography	9	54	1.7	1.3	71	3167	3.2	11
Biology	318	2512	60	63	364	7937	15.8	27
Chemistry (Theoretical)					19	78	9	2.7
Chemistry (Applied)	11	49	2	1.2	85	823	3.8	2.8
Geology (Theoretical)					22	413	1	1.4
Geology (Applied)	71	409	13	10.3	5	621	.2	2.2
Physics (Theoretical)					61	1090	2.7	3.8
Physics (Applied)	88	612	17	15.1	1585	14017	71	48
Psychology	28	200	5.2	5				
Total	532	3971			2238	28689		

Another very significant fact is that the biology is distributed very evenly throughout all of the magazines, whereas in the case of chemistry and physics 98 per cent of the articles and space

came from Popular Mechanics and the Scientific American. Such magazines as the Saturday Evening Post and Ladies Home Journal contained no references to either of the above sciences while in the cases of Good Housekeeping, Country Gentleman, and Farm Journal all of the items were under household or farm processes. All sciences were distributed rather evenly throughout the newspapers. In each issue, however, the biological material occupied on the average four times as much space as physical and ten times as much as chemical.

The general conclusions drawn from this study are as follows: first, biology is the most common branch of science occurring in the newspapers and non-scientific magazines selected for examination; second, omitting the two technical magazines, less than one-fourth as much space is given to physics and chemistry combined as to biology; third, the amount of space given to the theoretical side of physics and chemistry even in the scientific magazines amounts to less than one-half of one per cent of the total number of inches given to these subjects while in the case of newspapers and magazines for general reading it is almost negligible.

The writer is aware of the danger involved in drawing conclusions upon any subject with one set of data only. He realizes the possibilities for criticism in indicating changes which should be made in secondary school science courses as a result of this study. There are many more activities of junior and senior high school pupils in addition to their reading which will have to be analyzed before an adequate case can be established. Furthermore other studies of a similar nature like those of Caldwell, Curtis, and Powers will have to be included. However, with these limitations in mind, the following conclusions will be appropriate.

The first and most apparent inference to be drawn from this study is that biology is the most important of all secondary school sciences from the standpoint of general educational values. Physics would follow next in order, with chemistry third, geology fourth, and astronomy fifth. This conclusion is based upon the principle that the greater the frequency of occurrence of anything in the life of an individual the greater is the necessity that he know something about it. For example, if levers of the first class occur in more than one hundred different ways in ordinary life, while polarized light has only three or four possible uses, it is evident that a knowledge of levers is more important for general educational purposes than polarized light.

The second inference is that the sequence of sciences in secondary schools would be biology, physics, and chemistry. In a four year high school the program might well be general science, biology, physics, chemistry. In a junior-senior high school plan the sequence could be general science in seven and eight, biology in nine, physics in ten, chemistry in eleven and one-half year each of two other sciences in grade twelve. The evidence from this study is so pronounced in favor of the above sequence that there can be little argument against it without further investigation. Granting the order, a more important question is: in what year shall biology be placed and shall it be required of all pupils. The writer is firm in the belief that a subject which makes as many contacts with life as biology should be required of everyone and should be placed in that year in which it can reach the largest number of pupils. This would locate it in the ninth school year because of the elimination at the end of the first year of high school or the upper year of the junior high. There is not evidence enough of general use value to warrant the requirement of physics or chemistry. Whether they should be placed in the tenth and eleventh or eleventh and twelfth grades would depend upon other factors.

Third, the importance of biology, physics, and chemistry for general educational purposes does not correlate with the place assigned to them by the colleges as indicated through college entrance requirements. While biology is gaining slowly in its acceptance by colleges as meeting the science admission requirements, still the major sciences in this respect are physics and chemistry. Some colleges specify these two, others indicate one laboratory science which is interpreted to mean either physics or chemistry, while the second unit may be a non-laboratory science in which case biology or general science can be offered. Furthermore in cases where only one science unit is required it is advised that a laboratory science be taken and physics or chemistry is usually recommended. It is very evident that such demands and such recommendations do not harmonize with the notion that the most important of the secondary school sciences are the ones which enable boys and girls to perform better those desirable activities in which they are engaged. If this were the case we should find our colleges prescribing biology as the one required unit with the option of physics or chemistry as an additional unit in case two are needed.

Fourth, this study indicates the topics which are of major importance in secondary school science courses. For biology they are public health, knowledge of animal and plant life, foods, natural resources and evolution.[2] In physics the content would group itself around shop, farm, and household processes, automobiles, radio, aeronautics, structure of buildings, electrical power, photography, ship construction, tunnels, cement construction, bridges, electric signalling devices, highway construction, steam engines, motion pictures, player pianos, reclamation and drainage, railroad construction, steam turbines, storage batteries, X-rays, testing strength of materials, water supplies, and numerous other items of less than a two hundred frequency. For chemistry the major divisions would be shop, farm, and household processes, fertilizers, use of chemistry in promoting health, chemical uses of common metals, the production and use of alcohol including "home brews." The reader can draw his own conclusions as to how far the content of present courses of study agrees.

Fifth, the type of content suggested above would mean a new method in science teaching in secondary school. Instead of using the laboratory experiments which were developed by the discoverers of various principles and processes, for the purpose of justifying certain laws we should have in our physics laboratories appropriate units which would illustrate the workings of the machines mentioned above. These would be utilized as practical projects around which class problems would be centered. Scientific principles and information would be discussed in order to explain and interpret the construction, operation, and maintenance of these particular articles. What is true in physics would also hold for chemistry and biology. Our science laboratories would then be work shops, where pupils would start with materials within their interests and experience, where they would secure new visions of the utilization of the scientific principles involved, where they would obtain an intelligent appreciation of the value of science in the progress of civilization and become good consumers of the products developed through the scientific information of a few experts.

In a recent study,[3] Earl R. Glenn of the Lincoln School,

[2]These coincide with those given by Findley and Caldwell in Biology in the Pubic Press, New York, 1923.

[3]The summary as here given was presented by Dr. Otis W. Caldwell before a group of science teachers in Denver, Colorado, on February 13, 1924.

Teachers College, shows that in the 67 largest cities of the country the percentage of secondary school pupils taking physics ranged from one-half of one per cent in Pittsburgh, Pennsylvania, to 17 per cent in Portland, Oregon. The average was approximately 8 per cent. Ten years ago the average for these same cities was 14 per cent. It is possible that one of the factors contributing to such a condition is the type of physics courses now offered. With a reorganization along the lines suggested here where closer contact is made between the subject matter taught and the life experiences of pupils it would seem that many more boys and girls would be attracted to this subject.

The writer wishes again to make the point explicit that the conclusions drawn here are based solely upon the study which he is reporting. Other investigations will have to be made before final answers can be given to some of the questions raised. Meantime we will have to ask ourselves whether we will continue to hew to the old line or whether we will rearrange our science sequence and be content to harmonize with the results of modern research.

A NOTE TO TRIGONOMETRY TEACHERS.

By Mabel Sykes,

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In the October number of School Science Norman Anning describes a "Device for Teachers of Trigonometry." He opens this description with the remark that, "it is a common experience to find pupils who have difficulty in going over from the functions of an acute angle to the functions of a general angle."

The writer has done away with this difficulty by a change in the definitions themselves. When trigonometry was taught by the usual method this trouble was always encountered. One year one member of the class remarked, "Why did you not teach us a definition that did not have to be unlearned?" Since then the definitions based on the Cartesian Coordinates have been given at the outset; for example

$$\sin x = \frac{\text{ordinate}}{\text{distance}} \qquad \cos x = \frac{\text{abscissa}}{\text{distance}}$$

and so on. Here are definitions that will apply to an angle in any quadrant. Moreover if the facts that the ordinate must be read from the x axis and the abscissa and distance from the origin are included in these definitions and if the usual convention regarding signs of directed lines is given at the same time, a large amount of theoretical trigonometry is possible at the very beginning of the course.

These definitions are given in some text books. While many of these books may be considered too hard for high school pupils, the method here suggested is not too hard for them. No trouble arises when in a few weeks the solution of right triangles is introduced; the circular figure in which the lengths of certain lines represent the values of the various functions under certain circumstances, is no longer necessary; the pupil has at his command a set of definitions that do not have to be "unlearned."

SOME COMMENTS ON PHYSICS TEACHING[1]

By Herbert Brownell

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At the outset it may be well to state that it is proposed to make use of physics as type for all high school sciences, and to suit all comments to the sciences of secondary schools in general. However much college professors may magnify each his own particular field of science, in matters of teacher certification and in the minds of "educators" when discussing problems pertaining to secondary education, "science" is a composite. Its various subjects *when taken together* count as an educational unit. In some measure this explains the difficulty in satisfactorily framing a "science major," or a double major, for those planning to teach high school sciences.

As a background for these various comments on physics teaching, let it be kept in mind that it has been taken for granted that in very large degree there has been no such thing as "group consciousness" on the part of science teachers, and of others interested in the educational values of science taught in high schools. Lack of unity of interests on the part of college and high school science teachers has entered as a factor to bring to pass situations suggested rather than set forth in the comments which follow. Conditions culminating in the present-day state of affairs for high school science possibly may have been beyond the control of promoters of science instruction. Certainly there has been lack of adaptation of science teaching to changing conditions in high school instruction. Some of the changes which have occurred are set forth in the following data[2] for schools of the United States:

	1860[3]	1890	1900	1910	1920
Number of high schools	300	2,500	6,000	10,000	14,000

For the period from 1890 to 1920 the increase in number of high schools in this country *averaged more than one additional high school for every calendar day for this period of thirty years.*

From these same sources of information it is learned that 64 percent of the high school pupils of the country are in schools enrolling 75 pupils or less each, and but 5 percent of them are in schools enrolling 500 pupils or more. By a later compilation the enrollment of high school pupils of the country in towns of 2,500 population or less constitutes about 80 percent of all of

[1]Given before the Nebraska Academy of Sciences, May 8, 1925.
[2]Bulletin 19 (1920), Bureau of Education, Washington, D. C.
[3]Cubberley, History of Education, p. 701.

such pupils. Certainly one of the "problems" of secondary education is the problem of the small high school.

The growth in high school attendance during the forty years past has been one of the marvels of educational history, and one impossible of full comprehension by those who have been concerned with minor aspects of its development rather than the movement as a whole. To provide buildings and equipment to care for the throngs who crowded into high schools the various communities as "local units" taxed themselves to the limit, and placed burdens of taxation upon generations unborn. Administrative officials were driven frantic to suitably care for these high school boys and girls. Curricula were framed to meet the widest range of desires in different fields of learning, and were made flexible by all sorts of electives and substitutions of courses. An outstanding "net result" of such changes has been a decline in the relative importance of physics as a high school subject as noted in the following data[4]:

	1890	1900	1910	1922
Per cent of total enrollment taking Physics	22.2	19.0	14.5	8.93

Similar decline in relative importance, though not necessarily in numbers of students being taught, may be noted in other sciences as well. The fact that during this time classrooms and laboratories of the college sciences have been congested to the limit has in no small measure been due to the "group requirements" of college curricula rather than desires of students for the knowledge and training supposedly characteristic of science studies. Credits for graduation rather than attainment of any "scientific attitude of mind" have apparently been impelling motives all too commonly.

The mounting costs of high schools as of public school education in general led to the use of a "cost-accounting" system whereby to set forth the cost-per-pupil-instructed, and the relative outlays for all subjects taught in high schools. In this the science subjects made poor showing for reasons wholly obvious. Original outlays for rooms, furnishings, supplies and apparatus; upkeep and depreciation; small sections, especially the laboratory sections; and the relatively large teacher-time-per-pupil all have combined to make science instruction costly. And the excellent showings made by subjects in which large classes might be given instruction by a book-and-lecture system, and where the instructors could meet daily five and six of these large

[4]Bulletin 7 (1922), Bureau of Education, Washington, D. C.

classes, have operated to the discreditment of science subjects as requirements for graduation despite all the educational values of science so freely admitted.

Complaint has always been made by science teachers, both in season and out, of their especially heavy labors, and of a need to lighten teaching "loads" occasioned by heavy demands upon time and strength to provide suitable laboratory work. This has been the case especially in the smaller high schools with their inadequate equipment. From this and other causes has come a dismemberment of "science" in high schools to an extent of which possibly not all who are interested in the advancement of science are aware. In a distribution of "teaching-loads" the botany, let us say, goes to the teacher of French who has a vacant period and who in college took a 5-hour course in botany as a "group requirement". Her major interest is the language; the science is merely incidental to teaching conditions. The class in physics goes very commonly to the coach in athletics. He may have had some courses in college physics and mathematics, but it was wholly irrespective of any special interest in teaching them, or of making preparation for their teaching. His success as a member of the high school faculty, his tenure of position, and his promotions all depend on the success he has in and through his "teams". The science instruction is but a minor interest. The general science goes to any one whose teaching load and schedule of classes makes it desirable from the administrative standpoint regardless of lack of fitness, and of any protests by the teacher to whom the subject is given. In such ways as these in due time the dismemberment of science as a major unit of high school instruction becomes an accomplished fact in the smaller high schools.

To protests made to a superintendent of schools concerning this condition comes as justification for it, in addition to what has been set forth above, the further claim that nowhere are adequately prepared all-around science teachers to be had. As college graduates their preparation in science is confined very largely to one field only in which they have specialized. Other than in this field they are but little better prepared as high school science teachers than those whose majors have not been in science. It is to this condition, I suppose, that the Dean of a Teachers College refers when he says that science in the schools is "decadent." And this in spite of the marvelous advances in every relationship of life in both theoretical and applied science!

Once it was a common practice to prescribe as panacea for all the ills of science instruction in high schools "better prepared teachers." In some institutions for teacher-training, science departments were maintained and students urged to take at least a major or minor in "science" (not some single science). But with conditions such as discussed above why make any preparation at all to be a high school science teacher? For large city high schools with their separate science departments doing a college type of science instruction, the arts college graduate who has specialized in a particular science, and who may or may not have had courses in "Education," continues it would seem a more or less satisfactory candidate as a science teacher. But not even this source of supply for science teachers meets and solves the problem for small high schools.

And strange as it may seem, a notable growing tendency in some teacher-training institutions is to ignore the situation affecting science teaching in the smaller high schools. The requirements of courses in education, together with those for Teachers Certificates issued both by Teachers Colleges and by State Departments of Education, are not that a teacher-candidate be or shall become fitted to teach "science" in any case, but instead *that he be fitted to teach high school subjects*—history, mathematics, athletics, language, commercial branches, etc., etc. For all these varied fields the requirements in education courses are the same—courses in history of education, principles of teaching, and a "methods" course so general as to be suited equally well for all high school branches. These together with courses in school administration, educational psychology, and educational measurements make up a required fifteen hours of education. There is required commonly, too, a two-hour course in "special methods" in some one science subject before entering upon a course in practice teaching. Such is the "education" side of teacher-preparation for high school science teaching.

It may no longer be a question of whether or not one who knows subject-matter is thereby well-fitted for teaching it. Instead, it seems rather a question whether in teacher-preparation and in teacher-certification the preparation required shall be of a blanket type to fit the whole high school field, or be restricted to such special fields as the social sciences, the natural sciences, modern languages, etc., even as now is true of Agriculture, Home Economics, Manual Training, Music, etc. Till a special certification for "science" is in force instances multiply such as that of

the young woman graduating from the University here this year who having a major in history is assured of a position in one of the supposedly better high schools of the state to teach two classes of physics in connection with her work in history. By reason of having had no physics herself it is her announced plan *since she disliked all laboratory work* to so arrange her physics as to leave out the laboratory exercises. And when asked what she could do when in her physics classes some of the pupils might ask to be enlightened concerning radio and other matters of electricity, she was equally confident that electricity, too, might be left out of the course. A teachers certificate whether from a Teachers College or a State Department of Education licensing a candidate to teach in high schools permits what might be barred in large measure, at least by certification to teach "science," or some other distinct line of instruction. Such aspects of secondary school science instruction both discourage and distress those who are advocates of science instruction for educational ends as well as for enlightenment in scientific knowledge.

AUTHOR'S NOTE.—Since the above was prepared the author has had access to a Thesis presented by Miss Agnes Undeland (June, 1925) as partial fulfillment of requirements for a Master's Degree in the Department of Education, Graduate College, University of Nebraska, and now on file in Library of The University. Its title "Relation Between Subjects Taught And Teacher Preparation For The Schools Of Nebraska" is a key to its content. It is based upon Reports from some four hundred (402) public high schools including all Nebraska high schools belonging to the North Central Association. Apart from an illuminating array of facts having to do with the whole field of high school instruction, and from the writer's conclusions based thereon, there is noted here certain features only which pertain to the status of high school science. The thesis as a whole will be found a contribution of value in the field of secondary education.

1. Number of schools from whose Reports data was gathered---402.
2. Grouping of these schools: (I) Fewer than 5 teachers; (II) 5-10 teachers; (III) 10-20 teachers; (IV) 20 or more teachers.
3. Subjects grouped as "Science": Biology, Chemistry, General Science, Physics, Physiography, Physiology (and Hygiene), Zoology.
4. A "major" equals 20 or more college hours; a "minor", 12-20 hours; and 8-12 hours a "sub-minor."
5. Less than 8 hours academic preparation in a subject is not accounted "teacher preparation." Preparation in any science subject (one only) is accounted preparation for "General Science."

6. More than 70% of Nebraska high school teachers are in the smaller high schools, and tenure of position in these schools is less than in the larger high schools.
7. For the 402 high schools, physics was taught in 285; general science in 255; agriculture in 151; chemistry in 85.

TABLE I

Number of Teachers Who Teach

Groups	*One subject*[5]	*Two subjects*	*Three subjects*	*Four subjects*
I (1-5 teachers)	19	294	285	87
II (5-10 teachers))	192	433	185	32
III (10-20 teachers)	175	90	22	....
IV (20 and more)	313	54	5	....

Teachers who teach five subjects: Group I, 9; Group II, 3; Groups III-IV, none; 30% of all the teachers are in Groups III-IV.

TABLE II[6]

No. of subjects taught:	*One*	*Two*	*Three*	*Four*	*Five*
In Group I (694 teachers)	16	227	290	135	26
In Group II (845 teachers)	151	386	251	48	9
In Group III (287 teachers)	132	109	41	4	1
In Group IV (372 teachers)	287	69	15	1	..

Seventy-five per cent taught two or more subjects; 33 per cent taught three or more.

The range in number of subjects per science teacher, especially in Groups I-II, involves more than is apparent by reason of the fact that data considered here are compiled for one and the same semester only. As matter of fact a science subject taught in the first semester is often followed in the second semester by a different and perhaps wholly unrelated science taught by the same teacher.

TABLE III

Hours of Academic Preparation in Subjects Taught

Groups	20 hrs. and more	12-20 hrs.	8-12 hrs.	8 hrs. and less	*Totals*
I	459 trs.	408 trs.	243 trs.	587 trs.	1697 teachers
II	586 "	389 "	225 "	576 "	1776 "
III	227 "	78 "	34 "	131 "	470 "
IV	260 "	58 "	23 "	86 "	427 "
					4370 "

Nearly one-third of these teachers ($1380 \div 4370 = 31$ per cent) have had no sufficient academic training for the subjects taught by them.

[5]Science is here considered as one "subject." All the sciences are taken together even as history, mathematics, etc., are taken each as a unit "subject."

[6]Each separate science subject here counts as a unit.

INFORMATION EXERCISES IN BIOLOGY[1]

By J. L. Coopride

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Some difficulties in making educational tests in biology. The maker of an educational test in general biology for high schools is confronted from all angles with the lack of standardization. The subject matter of the texts in the subject is not standard. No two authors of texts seemed to have the same goal in mind when they wrote their texts. Some seem to be more or less "one sided" and place emphasis more upon the botany or biology or the zoology of biology or the human biology rather than upon general biology. Others seem to intercorrelate these phases of biological materials for the purpose of arousing interest in biological nature-study or to interpret the biological phenomena about the boy and girl in its relation to human welfare.

Again, the methods of presentation are not standardized. Some prefer the individual method to the demonstration method and *vice versa*. The plant and animal materials used by different schools is similar but not uniform. There are as many different kinds of laboratory equipment as there are different schools. Courses of study, if such are in acutal usage, vary with the supposed "needs and desires" of local schools.

The development of these Exercises. All of the difficulties are not listed above but those that are listed will serve as an introduction. In 1920 the author began a survey of the vocabularies of the text-books then published in high school biology. As a result of this survey, a preliminary test form was constructed and given during a period of two years following to about 350 students in general biology in high school. When this trial test was first given it contained 300 questions. After each administration some of these 300 questions were revised, some were canceled and some were added. Questions missed by all students were considered too difficult and those missed by no student were considered too easy and both were dropped. Ambiguous questions were discovered and reshaped.

In 1922 a second survey of the vocabularies of text-books was made. This survey was added to that made earlier, making a total of nine texts[2] that were surveyed. After this analysis the Exercises were again revised. An attempt was made to exclude

[1]Published by the Public School Publishing Company, Bloomington, Illinois. Sample copies may be had for ten cents.

as far as possible all biological terms that were not found in all of the nine texts surveyed, also to exclude all parts of the Exercises that were otherwise less valid. After this revision the Exercises were reduced to 100 fairly well selected questions. These were divided into six Exercises of about the same number of points each. When these Exercises are administered the student is confronted with a vocabulary of 226 different biological terms. In this whole test—

141 of these 226 terms are used one time only,
46 of these 226 terms are used twice,
26 of these 226 terms are used three times,
5 of these 226 terms are used four times,
2 of these 226 terms are used five times,
3 of these 226 terms are used six times,
1 of these 226 terms are used seven times,
1 of these 226 terms are used eight times, and,
1 of these 226 terms are used nine times.

Of this vocabulary of 226 different biological terms—

83% is found in 9 of the text-books analyzed,
86% is found in 8 of the text-books analyzed,
90% is found in 7 of the text-books analyzed,
93% is found in 6 of the text-books analyzed,
96% is found in 5 of the text-books analyzed,
100% is found in 4 of the text-books analyzed.

After the final revision of the Exercises, another analysis showed that—

38% of all the questions pertained to animal biology,
27% of all the questions pertained to plant biology,
18% of all the questions belong to the field of human biology,
17% of all the questions are of general biological nature.

This is in harmony with the findings of *Downing*[3]; *Finley*[4]; and *Mau*[5]; who found that the above are in the order of the interests of children in biological materials. More desirable criteria than

[2]Bailey and Coleman, First Course in Biology, [Macmillan and Co., 1908]; Bigelow and Bigelow, Applied Biology, [Macmillan and Co., 1911]. Hunter, George William, Essentials of Biology, [American Book Co., 1911]. Huster, George William, A Civic Biology, [American Book Co., 1914]. Peabody and Hunt, Elementary Biology, [Macmillan and Co., 1914]. Smallwood, Reveley, and Bailey, Biology for High Schools, [Allyn and Bacon, 1920]. Gruenberg, Benjamin C., Elementary Biology, [Ginn and Co., 1919]. Moon, Turman J., Biology for Beginners, [H. Holt and Co., 1921]. Atwood, Wm. A., A Civic and Economic Biology, [P. Blakiston's Son and Co., 1922].

[3]Downing, Elliot R., Children's Interests in Nature Material, Nature Study Review, 8:334-338, 1912.

[4]Finley, Charles W., Some Experiments in the Teaching of Elementary Science. SCHOOL SCIENCE AND MATH., 21:1-24, 1921.

[5]Mau, Laura Emily, Some Experiments with Regard to Relative Interests in Physical and Biological Nature Materials in the Kindergarten and the Primary Grades. Nature Study Review, 8:285-291, 1912.

those presented are desirable in the future for the validation of test materials.

Titles for the Exercises. By constructing six separate Exercises the author had in mind the breaking up of the monotony of "wading through" a list of 100 questions of about the same nature. The essential purpose of each Exercise is to test biological information as is suggested in the title of the test rather than to measure those skills, students may possess necessary to study biology or may develop as a result of that study. Each Exercise of the test is a type of educational measurement rather than a test of a certain mental process which is supposed to be involved in the study of biology. Tests of this later type, which measure those habits necessary to successfully study biology or habits gained by studying the subject surely must be developed. But this would be an extremely difficult task since such habits and skills peculiar to biology have not been determined scientifically.

Exercise 4 of the test was designated as a *Best Reason* test, but there is no reason why *Exercise 3* [*Information*], or *Exercise 5* [*Classification*], or *Exercise 6* [*Logical Selection*] could not also have been designated as "reason" tests. In each of the Exercises mentioned the student has to think [reason] in terms of his biological information, hence these Exercises become tests of information rather than tests of the "reason" ability of the student.

The information involved in some questions demand a knowledge of general biological laws, principles, concepts, fundamental processes, or definitions. Some questions demand a knowledge of functions, structure, and classifications of organisms. Problems are presented relating to health, environment, interrelation of organisms, evolution, life history, and habitats.

Arrangement of material. There being no time limit, neither the questions in the Exercise nor the Exercises themselves were arranged in order of difficulty. The author believes that scaling a test would be of value when there is a time limit and that a time limit would place an unnecessary handicap on the students. In an information test of any kind it seems to the author that a student should have all the time he needs to attempt all the questions, since such tests should determine the power of the student rather than his speed. For these reasons the time factor was omitted, and neither the questions, nor the Exercises were scaled.

Administration of the Exercises. In the construction of the Exercises special attention was given to simplicity and convenience of administration. The examiner need not be an expert in giving tests. It is possible for anyone to master the directions for giving the Exercises in a few minutes since these are few and simple. Directions to pupils for each Exercise are short and easily understood by the pupil and they are not read or discussed by the examiner, thus reducing the personal equation to the minimum.

The form and length of the Exercises usually appeal to the students as being a piece of work that they can do well and not another "brain teaser" or "another ordeal to go through." No communication is permitted either before, during or after the administration of the Exercises. When a test is announced certain questions naturally arise, such as—When do we begin? How much time do we have? Shall we use pencils? etc. Such questions should be answered and the answer of the examiner should be of such a nature that it will demand attention and obedience. Some questions are taken care of if the examiner announces that beginning and mid-year students are not expected to answer all of the questions but that they are expected to answer all that they can.

The length of the Exercises makes it possible to administer the test in a regular 40 minute period. The slowest pupils seldom require more than 40 minutes and most students are done in 25 to 30 minutes. Students who use more than 40 minutes or less than 15 minutes need special investigation, and, in a large number of cases they will be found to be wasting their time.

Scoring. In three Exercises of the test, students are asked to draw a line through one word which indicates the correct answer. This makes it possible for a stencil to be used in scoring. This stencil may be cut from one of the test forms by the use of a sharp knife or razor blade so as to leave holes at the places which will show the correct answers. When the stencil thus cut is placed over a paper the correct answer can be seen at a glance and the correct score recorded very quickly. In two Exercises the questions are so arranged that the correct answers have a key which is easily learned. For example, in Exercise 4, which is a "Best Reason" test, there are four possible ways of answering the question, each answer being numbered 1, 2, 3, and 4. The correct answer to the first question is number 2, for the second question it is 4, for the third question it is 1, and for the fourth

question it is 3. So the key for this Exercise goes like this—2, 4, 1, 3, 2, 4, 1, 3, 2.

In all of the Exercises, except Exercise 4, the score is the number correct. In Exercise 4 the score is twice the number correct. One Exercise is of the true-false type, but the score for the Exercise is the number right and not the number right minus the number wrong. The author believes the R-W method of scoring is of poor diagnostic value and that it is about discredited, especially in tests in which the possibility of getting a high score by guessing is no greater than in tests of other kinds. A student may know 50% of his subject matter and make a negative score. The author has in mind a large number of students, who at the beginning of the year in biology got but two of the sixteen questions correct, and, who at the end of the mid-year got seven or eight questions correct, but in both cases the score would be zero under the R-W method of scoring. If a student misses almost all of such questions at the beginning of his course, and then can answer half of them at the mid-year point, it seems to the author that he has added to his knowledge of the subject, and that he should be given credit for the number he gets right.

The Exercises have been given to October, 1925, in their present form to 1026 high school students in biology, and the norms for these are given below. These averages should be considered as tentative standards, although additional scores do not seem to alter the present standards. The mean score made by students who have not had biology before is 29; for those students who have had biology one-half year the mean is 46; and, for those students who have had biology one year the mean score is 58.

There were 160 of these students who had the Exercises administered to them a second time in two consecutive days. The coefficient of reliability according to *Brown's* formula[6] is .92, which seems to be exceptionally high. The correlation of the scores of these same 160 students with their teachers' estimates is .70, which again is fairly high.

The validity, reliability and correlation outweigh the value of standards as to usefulness. The writer is more or less pessimistic as to the value of norms secured from large number of schools. There is a marked difference in scores secured from

[6]Brown, Wm., The Essentials of Mental Measurement. Cambridge University Press, London, England, pp. 101-2. 1911.

different states, cities, and even schools in the same city. Securing norms from large numbers should not be discouraged but these seem to be of little value when applied to a single group, save for the purpose of comparison and this is of little value. It seems to be far more important to obtain a relatively fair ranking of the students of one school than it is to make comparisons between students of one school with other schools in different localities.

Value of the Exercises. The Exercises have been found to be very helpful in furnishing—

1. A quick means of securing a reliable and objective mark or score to supplement the judgment of the teacher in making promotions. The user of any test should not be blinded by the test itself however perfected, and base marks wholly upon one test. There are other objectives in biology that we must not lose sight of, namely, spirit of investigation, appreciation of nature, scientific habits, increased love for home, friends, and state, respect for laws both of state and nature, etc.

2. A quick way of arriving at the probable biological information of classes at the beginning of the year and at the midyear. This information could be used as an aid in a more scientific classification of pupils. However, this test should not be used alone as a basis of classification. The result of any one educational or mental test or performance is not sufficient evidence to secure the class rank, but rather more than one measure together with teachers' judgments should be used.

3. A good check on the progress made during the course. The progress made by students should aid in the determination of promotions, failures, and classifications as much as the extent of the biological information of the student. A student may have a large range of biological information at the beginning of the year, and his progress may be marked or not noticeable. A poor student may have a small range of information at the end of the course and a smaller range at the beginning. The score of this poor student at the end of the course may be less than that of a stronger student at the beginning of the course. But the progress of this poor student may exceed that of the better student by several points. The writer often makes a frequency table of the progress of students as shown on the Exercises and uses this along with other frequency tables and other data in determining the success of his students.

This account is not offered as an excuse for the Exercises as published, nor for the tentative nature of the norms. The author is desirous for several good tests in biology and makes this feeble attempt to add one to the very small list of such tests. It is hoped that these Exercises will be outclassed by later forms of tests that will better meet the needs of high school biological instruction. In order to help establish norms, of whatever value they may be, the author would appreciate the cooperation of users of these Exercises in reporting the scores on the blanks provided for that purpose.

"AN INVESTIGATION IN THE TEACHING OF THE SKILLS OF NINTH GRADE ALGEBRA"

By Raleigh Schorling and Selma A. Lindell

University of Michigan, Ann Arbor, Mich.

Purpose. The purpose of this study is to measure the effect of applying certain principles from the psychology of drill. In recent years considerable gain has been achieved from our knowledge of habit formation. It is now possible to formulate over twenty principles that are generally accepted in psychology but which are not applied in our school texts in algebra.

These principles may be illustrated by the following: (1) There should be much practice on a few skills rather than a little practice on each of many things. (2) A drill exercise must be specific. (3) Drill, to be effective, must be individual. (4) Drill must provide a scoring techinque so that the pupil may know the degree to which he succeeds. (5) Drill should make possible the diagnosis of individual difficulties. (6) Practice should be distributed in decreasing amounts at increasing intervals. (7) A drill exercise should be standardized so that the pupil may have at least a rough notion of his degree of skill. (8) A drill exercise should be relatively short. Probably an approximate time for concentrated work in the ninth grade is between eight and ten minutes. (9) A drill exercise should set up a high standard of accuracy. The scheme for drill should make it possible for the pupil to take the same exercise again and again until he has achieved an accuracy that allows only the occasional slip.

The foregoing is probably a list sufficient to illustrate the very definite guiding principles for habit formation that the investi-

gators have in mind. How effective are these principles in contrast with the usual "hit or miss" plan?

Experimental Material

The experimentors, with the help of Dr. John R. Clark, have constructed a booklet of teaching materials which aims to apply consistently and throughout these well recognized principles of drill. This booklet is entitled "Instructional Tests in Algebra". It consists of fifty-two goals and is adjusted for pupils of varying abilities.

General Plan of This Experiment.

(1) A teacher taking part in this experiment will teach two or more algebra classes. During the first month all classes will be taught in the usual way the material in some standard algebra text already in use in the particular school system concerned.

(2) Beginning with the fifth week the Experimental classes will take ten minutes each day at the beginning of the hour to use the experimental booklet described above. The rest of the recitation period will be spent on convential materials drawn from the regularly used text books.

(3) It is important to note that each teacher taking part in this experiment will have at least one *Control* group, that is, she will teach one class without modifying in any way the course that is regularly given in that city.

(4) An algebra test will need to be given to all groups at the beginning of the year. Considering the fact that all pupils will be beginning algebra it might seem that this step is unnecessary. There are at least two reasons why a test is essential. In the first place there will be repeaters. In making the final report at the end of the school year all papers of pupils repeating algebra either in the Experimental class of the Control class should be rejected. In the second place, many cities are now studying general mathematics in grades 7 and 8. In these courses pupils learn some algebra, and it is conceivable that bright students might bring considerable skill in certain aspects of algebra to the 9th year course.

(5) Comprehensive tests will be given at the end of the school year to both the Experimental and Control classes. This test will consist of parts drawn from the various standardized tests in algebra.

How Materials May Be Obtained

(1) The test for the beginning of the experiment consists of

two parts: the Addition and Subtraction Test and the Equation and Formula Test by Hotz. These tests may be secured from Dr. C. Woody, Ann Arbor, Mich.

(2) The *Experimental Booklet* can be obtained by writing to George Wahr, Publisher, Ann Arbor, Mich. The 72 page booklet is furnished at a cost of 30 cents per pupil.

(3) At the end of the year a cooperating school may administer to both groups the complete form of any one of the following tests: 1. The Hotz First Year Algebra Scales, (Teachers College Bureau of Publications, New York City). 2. Diganostic Tests for First Year Algebra by Professor Harl Roy Douglass. (For the test write Professor Douglass, University of Oregon, Eugene, Ore.) 3. The Thorndike Algebra Tests To Quadratics Form A. (For the test write the Insitute of Educational Research, Teachers College, New York City.

In some schools it may be difficult to administer a formal test such as is mentioned in the preceeding paragraph. For such schools a *special final test* will be supplied.

This final test is to be specially constructed for measuring the outcome of one year of algebra in the two groups concerned.

The test will be furnished on May 15th without cost by the investigators upon special request of a cooperating teacher. For this test write the experimentors direct.

Conditions of This Experiment

This investigation will be conducted intensively in a limited number of schools in which it is arranged:

(1) To give the tests at the beginning of the experiment to both groups.

(2) To administer the Experimental Booklet according to directions provided in the booklet.

(3) To administer a comprehensive test at the end of the school year to both groups.

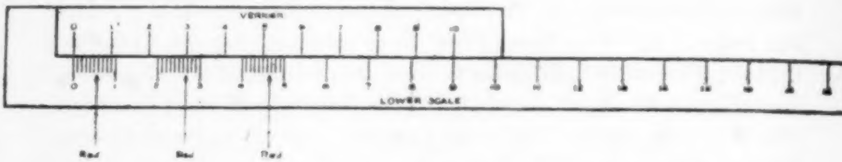
(4) To write to the investigators before May 15, 1926, for the blank form on which the results of the experiment will be reported to the experimentors.

Those who are especially interested in this experiment should notify the investigators and make certain that they have the Experimental Booklet at the beginning of the fifth week of school this fall.

THE HARBOR MODELVERNIER

By L. A. Sprague

When students are learning to read the vernier, we have found the following simple device helpful in getting them to understand that the vernier only shows but does show how many tenths of the last unit are included in the quantity measured.



We have made a large model vernier about eight feet long. The units on the lower scale are 2½ inches long. The units on the vernier are 2¼ inches long. These are all heavy black lines. Two or three units on the lower scale are divided into tenths, that is, ¼ inch. These are in bright red. This model vernier is used for drill purposes in class. When it is set at one of the units which have been subdivided on the lower scale the student can check his vernier reading with a direct reading on the lower scale. He need not become dependent upon the red lines because most of the drill can be on other units than those subdivided.

STAMPS CONVEY KNOWLEDGE OF HISTORIC OCCASIONS.

"Postage stamps are an effective means of stimulating loyalty and patriotism. Everybody who posts or receives a communication through the United States mail receives, nolens volens, a transitory lesson in the history of the Nation," says Harry S. New, Postmaster General, in an article in School Life, a publication of the Interior Department, Bureau of Education.

"In general the designs upon the regular issues have included the representation of the head of one of the Presidents, but in the past 50 years the custom has grown of commemorating important historical events by special issues," states the Postmaster General. "The novel appearance of the new stamps immediately arrests the attention of the user, and inquiry into its meaning naturally follows. The result is a valuable lesson in history which few escape, even those of limited education.

"Thirteen special series of adhesive stamps have been employed to impress historical occasions upoh the popular mind," Postmaster General New continues. "They have carried to thousands their first knowledge of some of the events which were thus celebrated, and they have led millions of our people to a wider and more intelligent understanding of the circumstances that have contributed to our national existence."
—Science Service.

A GENERAL SCIENCE TEST.

By Herbert A. Toops,
Ohio State University, Columbus.

The writer has had many requests for copies of a general science test constructed in 1919. It is here presented as an example of how to construct such a test, based upon the one-word-answer principle.

It is relatively easy to construct an objective test by use of one-word-answer question. The construction of such a test involves only three essential steps:

1. Select the facts or principles, which are to appear as questions of the test, in such a way that an adequate sampling of the subject matter results.

2. Select some objective or technical word or numerical fact for an answer, and then—and then only—construct the question by wording it in such a manner that no other answer than the intended answer may be given by a person who knows the true answer. That is, write the answer first, and then write the question.

3. Try out the questions thus formulated upon some critical person whose business it is to attempt to evade giving the intended answer by answering some other "correct" answer. On the basis of this tryout revise the wording of the questions.

In step 1, we proceed to collect from the text many declarative sentences such as:

a. "The two fixed points on the Centigrade scale are zero and 100."

b. "Carbon dioxide, a colorless gas, is formed when carbon burns."

c. "The coloring matter of green plants is called chlorophyll. It is not present in mushrooms and parasitic plants."

The sentences are to be selected more or less at random from the different chapters of the book roughly in proportion to the number of pages per chapter. Inasmuch as the one-word-answer type of test has higher reliability than the multiple choice form, a smaller number of questions will suffice.[1]

A hundred questions will probably give enough for a satisfactory reliability. The questions can be answered by high school seniors at the rate of about three to five per minute. These considerations will tell one something of how many questions to construct.

[1]Toops, H. A.—Trade Tests in Education, T. C. Contribution to Education, No. 115, 1921 pp 39-54.

In step 2, we decide upon the technical word for the answer and formulate the question. For sentence (a) above we may write:

1. At what Centigrade temperature does water freeze? *Ans. Zero (0).*
   or
2. At what Centigrade temperature does water boil? *Ans. 100.*
   or
3. What temperature scale has the boiling point at 100 degrees? *Ans. Centigrade.*
   or
4. What common substance boils at 100 degrees Centigrade? *Ans. Water.*
   or
5. What marking on the Centigrade scale corresponds to the marking of 32 degrees of the Fahrenheit scale? *Ans. Zero.*
   or
6. What marking on the Centigrade Scale corresponds to the marking of 212 degrees of the Fahrenheit scale? *Ans. 100.*
   or
7. How many degrees are there between the freezing point and the boiling point on the Centigrade scale? *Ans. 100.*
   etc., etc.

Quite a few of the above seven questions may be reversed, or may be applied to the Fahrenheit and Reaumer scales as well. Thus it is often readily possible to construct many alternative questions about the same simple facts, and so provide many alternative forms of the examination to prevent coaching; to measure improvement; for use in controlled experimentation in determining the best method of teaching the subject, and so on.

In step 3, the critical answerer tries to evade giving the answer to the above questions which we have constructed. In this process the allowable alternative or synonomous answers often make their appearance. These are to be written in parentheses on the scoring key.

In the test below the allowable alternative answers are given in parentheses. Any one of the allowable answers receives full credit. The score is the number of answers answered correctly. Misspellings of answers if otherwise correct, are not counted wrong. The fifty items are arranged in increasing order of difficulty, as determined from the responses of college freshmen. The test is not scaled.

Toops' General Science Test

(Based on Caldwell and Elkenberry's "General Science")

Read each question and then answer it on the line at the right. A single word or number is a sufficient answer to every question. *Time allowed (inclusive of time to read directions):—16 minutes.* Samples:

In what year was America discovered? *1492* A

What color are ripe strawberries? *Red* B

Per Cent of Failures by University Freshmen		Write your Answers Here	
6.	Of what two chemical elements is water composed?	*Hydrogen and Oxygen*	1
7.	What insect carries malarial fever?	*Mosquito (Anopheles)*	2
9.	What do you call the method by which arid or desert lands are made productive?	*Irrigation*	3
11.	What do you call the yellow, dust-like grains often found on a flower?	*Pollen*	4
14.	What do we call it when the moon is directly between us and the sun?	*Eclipse*	5
18.	What instrument is commonly used to measure the atmospheric pressure?	*Barometer*	6
20.	What liquid would you pour on stagnant water to prevent mosquitoes developing there?	*Kerosene (oil)*	7
21.	What liquid is used in an artificial ice making system to freeze the water by its evaporation?	*Ammonia*	8
22.	What is air in motion called?	*Wind*	9
23.	What would you do to air to make it expand without changing the pressure on it?	*Heat (warm)*	10
23.	What microscopic plant is used to produce fermentation in bread?	*Yeast*	11
24.	When air has absorbed all the water vapor possible, in what state is it said to be?	*Saturated*	12
26.	What temperature is the freezing point on the Centigrade thermometer?	*Zero* (0)	13
26.	What astronomical body causes our tides?	*Moon*	14
28.	What chemical substance is formed when carbon burns?	*Carbon-Dioxide* (CO_2)	15
34.	What name is given to all the factors which surround us and affect our lives all the time?	*Environment*	16
35.	What food substance is found in great abundance in the white of an egg, cheese, and lean meat?	*Protein (Albumin)*	17
36.	What supplies the force for applying the brakes on railroad cars?	*Air (Compressed Air)*	18
39.	I put 100 foot-pounds of work into a machine and get 80 foot-pounds out of it; what is the efficiency in per cent of the machine?	*Eighty (80)*	19
41.	What is the chemical symbol for potassium?	*K*	20
44.	How many foot-pounds of work do I do in lifting a 10-pound weight a distance of 1-2 foot	*Five* (5)	21
45.	What do you call a cyclone which originates over the ocean?	*Hurricane (Typhoon)*	22
48.	What do you call the piece of apparatus used to make water run up-hill in emptying a glass?	*Syphon*	23
50.	What term is used to speak of the wearing away of rocks and soil by the wind and water?	*Erosion*	24
50.	What do you call the stage in a frog's life between the egg and adult frog?	*Tadpole*	25
55.	What is the stationary point called, about which a lever moves?	*Fulcrum*	26
56.	What physical principle is involved in the absorption of food by the roots of a plant?	*Osmosis*	27
57.	What instrument is used to change a high voltage power transmission electric current to a 110-volt current for household use?	*Transformer*	28
57.	What acid is used in a storage battery solution?	*Sulphuric* (H_2SO_4)	29

58.	What important substance, ordinarily found in green plants, is lacking in mushrooms?	*Chlorophyll*	30
59.	Which planet is surrounded by rings?	*Saturn*	31
59.	How are new grapevines started?	*Cuttings (slips)*	32
64.	What kind of weather is indicated by a barometer which steadily remains high?	*Fair (clear) (dry)*	33
65.	What would soon be the result if an animal was able to reproduce as fast as inherently possible	*Overproduction*	34
65.	What industrial machine, employing the principle of water pressure, is used to exert enormous pressures?	*Hydraulic Press (Cotton Press) (Baler)*	35
67.	What gas makes up the largest part of the composition of the air?	*Nitrogen*	36
68.	What instrument is used for testing the solution of an automobile storage battery?	*Hydrometer*	37
70.	What do you call the humidity which is always expressed as a percentage?	*Relative*	38
70.	Of what material is the positive pole of a dry battery made?	*Carbon (C)*	39
71.	What do you call any plant upon which a parasitic plant is dependent for nourishment?	*Host*	40
72.	My electric toaster uses 600 watts electricity; how many cents will it cost to burn it for 2 hours at 10c per kilowatt hour?	*12*	41
75.	What is the common name for the nitrate fertilizer imported from Chile?	*Saltpeter*	42
77.	What device is used to make an electric wire safe against too heavy a current?	*Fuse*	43
79.	How many million miles is it from the earth to the sun?	*(91) 92 (93)*	44
80.	What are all the petals of a flower, taken together, called?	*Corolla*	45
82.	In what form does most of the loss in electrical power transmission take place?	*Heat*	46
82.	How many inches of mercury will the air pressure support at sea level?	*30 (Anywhere from 29.5 to 30.5)*	47
87.	What planet is nearest the sun?	*Mercury*	48
89.	What are the massive, white rainclouds called?	*Cumulus*	49
91.	Upon what number are the death rates from typhoid fever based?	*100,000*	50

The norms for this test determined from 515 university freshmen taking elementary psychology are as shown on page 821.

The test was given to nine different sections of college freshmen in elementary psychology in an attempt to discover whether a knowledge of a student's previous science training, as represented by scores on this test, would improve the predictions of marks in elementary psychology made from the Ohio State University intelligence test. The results are given in Table 1.

Table 1. Intercorrelations of Intelligence, General Science Test and Psychology Marks, and the Multiple Correlation of intelligence and general science with Psychology marks in the case of nine sections of First and Second quarter psychology.

(The second quarter psychology is a continuation of first quarter elementary psychology.)

Percentile	Corresponding Number of items correct
Lowest score	
10	15
20	18
30	21
40	23
50	25
60	27
70	29
80	32
90	37
Highest Score	45
Number of cases	515

Section and Quarter	N	Correlations of			Multiple Correlation Predicting Marks
		General Sci. Test and Psy. Marks	Intelligence Test and Psy. Marks	Intelligence Test and Gen. Sci. Test	
First Quarter:					
Section A	60	.20	.52	.46	.52
Section B	42	.03	.23	.45	.24
Section C	48	.35	.52	.43	.53
Section D	95	.31	.25	.50	.33
Section E	66	.33	.24	.52	.34
Section F	37	....	....	.42	....
2nd Quarter					
G	78	.30	.31	.26	.38
H	40	.18	.36	.58	.36
I	49	.14	.36	.48	.36

From the above table it will be noted that the general science test correlates rather low with psychology marks; and that the general science test, with but two exceptions, correlates between .40 and .50 with intelligence. For these reasons the addition

of the general science test to the university intelligence test does not yield a multiple correlation for the two tests which is much higher than the correlations of the intelligence test alone. The correlations of intelligence with psychology marks vary from .23 to .52. We have reason to believe that the two correlations of .52 are as high as they are because of superior motivation.

In section A, the results of a reading test were available also. The intercorrelations are given in the following table.

r of psychology marks and general science	.20
r of psychology marks and intelligence	.52
r of psychology marks and reading	.47
r of general science and intelligence	.46
r of general science and reading	.46
r of intelligence and reading	.69
Multiple correlation of general science and intelligence with psychology marks	.52
Multiple correlation of general science and reading with psychology marks	.47
Multiple correlation of intelligence and reading with psychology marks	.54

The conclusion from the multiple correlations presented is that neither reading or general science much improve the predictions of marks made from intelligence alone. Those students who are poor in the science test, if of high intelligence or if able to read well will succeed in psychology almost as well as if they were good in general science. This demonstrates only that the psychology is taught with but little reference to any science principles which must be in the possession of the student at the time he enters the course. Such science analogies as the psychology instructor may use are capable generally of being understood by the bright student or by the good reader without previous knowledge of general science as measured by this test.

Summary:

1. A general science test has been presented as an example of how to construct such a test.
2. The most important rule for such test construction is: Decide on the desired answer first, and then write the question to fit it.
3. College freshmen norms are given.
4. Data on nine college sections in psychology indicate that the test correlates low with psychology marks in university freshmen classes. This does not indicate that the freshman needs no science for the study of psychology but probably rather that instructors have been compelled to use very simple scientific analogies—such ones as a bright student or good reader can readily grasp upon presentation by the instructor.

THE STRUCTURE OF THE ATOM.

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The developments and discoveries in the field of physics in the last twenty-five years have raised interesting questions as to the nature of matter, and upset many of the older notions in regard to the structure of the molecule and the atom. Since the discovery of the electron, the atom can no longer be considered the ultimate division of matter. The theories of hard or solid atoms break down in the light of recently discovered phenomena of radioactivity and the X-ray. Many intricate problems have arisen which demand the division of the atom, and yet its integrity as a chemical unit remains a fact. The search for a suitable explanation has occupied the attention of the foremost physicists of the world, but the most satisfactory one yet advanced is that of Neils Bohr of the University of Copenhagen, whose theory will be briefly outlined in the following pages.

The essental postulates of this theory are as follows:—The atom consists of a positive nucleus and one or more negative particles (electrons) which revolve about the nucleus at distances very large compared with the diameter of the individual particles. These electrons have definite "stationary" orbits in which they can revolve about the nucleus; an electron may pass from one orbit to another, but cannot remain in the space between two orbits. Radiation from the atom occurs only when an electron passes from one orbit to another one nearer the nucleus; external energy must be introduced to displace the electron to a more remote orbit. These postulates, briefly stated, require further explanation as to their significance and experimental facts upon which they are founded.

Historically the subject of atomic structure may be said to have had its origin in the experiments on the discharge of electricity through gases at low pressure in some form of discharge tube first investigated by Sir William Crookes. In 1895 Sir J. J. Thompson proved conclusively that the cathode rays, discharged from the negative electrode of the tube, consisted of negatively charged particles, called electrons. He measured the velocity of these particles, and the ratio of their charge to their mass, which he found to be constant for all ordinary velocities of the electron. Later, Professor Milliken determined experimentally the charge on the individual electron to be 4.77×10^{-10} electrostatic

(A brief report based on the investigations of Rutherford, Bohr, Crowther, Aston, and Compton, with special emphasis on the published work of Bohr.)

units. The mass of the electron was found to be 8.96×10^{-28} gram, or about 1/1800 of the mass of the lightest atom known, the hydrogen atom. Moreover, this mass can be shown to be entirely an electrical effect due to the charge which the electron carries; hence the electron constitutes a real "atom" of electricity. Electrons can be produced in all substances; they are all exactly alike except in their velocities; every electrical charge discovered is an exact multiple of the charge on the electron: Hence the electron must be a fundamental constituent of all matter.

The other fundamental constituent of matter is the positive particle, called the proton. In the discharge tubes where the electron was first observed appeared another discharge in the opposite direction from the cathode rays, and on analysis this discharge was found to consist of positively charged particles, each having a mass equal approximately to the mass of the atom of the substance from which it was derived. It would appear from this fact that there is a separate positive particle for each element. The phenomena of radioactivity, however, indicate that this is not the case. The α-particles emitted from radioactive substances are atoms of helium; and since these atoms are ejected from atoms of greater mass, the original atomic nucleus must have been constructed of a number of units at least as small as the helium atom. The latter is found to have four times the mass of the hydrogen atom; hence it is generally agreed that the helium nucleus contains four hydrogen nuclei, and that probably every atomic nucleus is composed of a number of hydrogen nuclei, this assumption being based upon much expermenal data that indicate its truth. Furthermore, nitrogen has actually been disintegrated by bombarding its atoms with α-particles, yielding hydrogen as the result. Experiments with the force actions between these positive particles show that they must approach each other nearer than 10^{-13} cm.; therefore the radius of the positive particle is less than 10^{-13} cm., or considerably less than that of the electron. It can be shown that a particle of radius α carrying a charge Σ has a mass due to its charge equal to $2\Sigma^2/3a$. According to this formula, electromagnetic mass is inversely proportional to the radius of the particle, and the proton will have an electromagnetic mass equal to that of the hydrogen atom (approximately) if its radius is 1/1800 that of the electron (Σ being the same for both). It seems probable, therefore, that all mass is electromagnetic and that the nucleus of the hydrogen atom is the ultimate positive particle.

How, then are these two fundamental divisions of matter grouped to form the many different atoms? The theory of Bohr and Rutherford can best be understood by taking first the simplest case, that of the hydrogen atom. The mass of the hydrogen atom is practically equal to the mass of the proton, and the nuclear charge is a single positive charge. Hence the neutral atom must contain one proton, and one electron to neutralize the positive charge. The electron revolves about the nucleus in an orbit whose size determines the size of the atom, and the orbit, according to Kepler's first law is an ellipse with the nucleus at one focus and a major axis equal to $2a = \epsilon^2/W$, where ϵ^2 is the charge on the electron and W is the work which must be added to the system to remove the electron to an infinite distance from the nucleus. The frequency of revolution in this orbit is given be the equation $\omega = \sqrt{2W^3/\pi^2\epsilon^2 m}$ where m is the mass of the electron. It is apparent from these equations that by varying W any values of $2 \propto$ and ω can be obtained.

At this point we are at once led into three difficulties. How can such a simple system produce the spectrum of hydrogen, with its lines all the way from the red to the ultra-violet? If this spectrum be due to different values for the orbit of the electron, we must at once assume that the orbit cannot vary continuously between wide limits, since the spectrum is not continuous. Furthermore, according to the ordinary laws of electrodynamics, the oscillating electron would continuously radiate energy, thereby decreasing its orbit until it finally lost all its energy and fell into the nucleus.

A method of escaping these difficulties has now been found in the application of ideas of the "quantum" theory advanced by Planck, which is a radical departure from previous conceptions in that it is the first instance of the assumption of discontinuity in the formulation of the general laws of nature. Planck in his experiments in heat radiation discovered that results did not agree with predictions based on the wave theory of radiation, that energy was not radiated continuously but in definite units or quanta, which he found to be equal to $\delta = h\sqrt{}$, where $\sqrt{}$ is the frequency of the radiation and h is a universal constant found to be $6.55 \times 10^{1-27}$ erg-sec. The success of this theory in its application to the phenomena of photo-electricity, X-rays, specific heat, and conductivity has led to its acceptance by scientists as one of the fundamental laws of radiation.

In its application to the problems of atomic structure, the

quantum theory rests on two postulates: First, there are certain states in which the atom can exist without emitting radiation, although the particles are in accelerated motion relative to one another; and these so-called "stationary" states possess a peculiar kind of stability, so it is impossible to add energy to or remove energy from the atom except by a transition of the atom into another of these states. Second, each emission of energy resulting from such a transition consists of a train of harmonic waves, the frequency of which does not depend upon the motion of the atom but is determined by Planck's equation $\delta = h\surd$ δ in this case being the total energy emitted during the process. The interpretation of the hydrogen spectrum is now more clear. This spectrum consists of a series of lines, the frequencies of which are given by the Balmer formula

$$\surd = K[1/(n'')^2 - 1/(n')^2]$$

where n'' and n' are integers. The hydrogen atom, therefore, is believed to consist of a proton with an electron revolving about it in an orbit represented by an integer, a line of the hydrogen spectrum being produced by a radiation emitted during the transition from the orbit n'' to the orbit n'.

"On the whole," says Bohr, "we may say that the spectrum of hydrogen shows us the formation of the hydrogen atom, since the stationary states may be regarded as different stages of a process by which the electron under the emission of radiation is bound in orbits of smaller and smaller dimensions corresponding to the states with decreasing values of n''. The orbit described by the electron is connected with the energy of the atom in a simple way. By applying Planck's formula for frequency to the Balmer formula, it is found that the energy of the electron in the nth stage, assumed to be numerically equal to W (above) is given by the equation $E_n = Kh/n^2$ Kepler's formula $2a = \epsilon^2/W$ then becomes $2a_n = n^2\epsilon^2/hK$. It is thus possible to calculate the orbit for each value of n. The final result of the binding process leads to a quite definite stationary state where $n=1$, which corresponds to the minimum energy of the atom and is called the normal state. An interesting check on the correctness of these calculations is the fact that the theoretical expression determined for K agrees closely with the empirical value of the Rydberg constant for the spectrum of hydrogen.

We may extend our study to the atoms of other elements. A combination of protons is found to have a smaller mass than the sum of the individual masses, so that the hypothetical unit

atom of unit mass into which all other atoms are divided has actually a smaller mass than the hydrogen atom of mass 1.008. The weights of all other atoms, however, are whole numbers, based on this unit. Helium, the next element to hydrogen in the periodic table, has an atomic weight of 4 and a nuclear charge of 2. Hence if the helium nucleus contains four protons, as is necessary for its mass, it must contain also two electrons to neutralize two of the positive particles. The way in which this combination is bound together is not definitely known, but there are evidently very powerful internal forces, as this is one of the most stable of combinations and cannot be disintegrated by any known means. About this nucleus are two electrons revolving presumably in their orbits in a manner similar to the one electron of the hydrogen atom.

Many theories have been advanced as to the structure of the nuclei of more complex atoms and the arrangement of the outer electrons. In all cases, according to the theory, the mass of the atom is determined by the number of protons in its nucleus, and its chemical properties by the number and arrangement of the outer electrons, which correspond in number to the atomic-number of the element in the periodic table. In the nucleus of the atom there is never less than one electron to every two protons; these electrons probably serve to bind together the antagonistic positive charges. In order to account for the periodic table it has been suggested that the outer electrons are grouped in rings, each ring corresponding to a series in the periodic table. All the inner rings are complete, but the outer ring contains any number up to the maximum, the number determining the position of the element in the series.

The theory of atomic structure has been verified, reasonably, for elements of small atomic weight, but its application to the more complex atoms presents such difficulties that at present all the results are of a somewhat speculative nature. Bohr's theory as it now stands is incapable of explaining the important points of stability of the atom and chemical properties, but there is evidently so much of truth in it that it will probably be extended in the future to lead to a more perfect and comprehensive knowledge of the ultimate structure of matter.

THE CONDUCT OF LABORATORY WORK IN ELEMENTARY CHEMISTRY.

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Any conscientious teacher will puzzle a great deal over the supervision of laboratory work for beginners in chemistry. The writer used to say this was a very grave problem to the teacher of chemistry in the first years of his experience. But now he is inclined to say it is just as grave to the older teacher as it is to the younger one. General ideas concerning character of experiments and printed helps in manuals can be disseminated in such a way that the older the science is and the more experience the teacher has, the less will need be the worry over these things. However when it comes to personal supervision, the development of educational schemes, the advancements in the special subjects as well as the wide variations in the intellectual characteristics of human groups; the problem becomes much more complex, and when it comes to personal assistance of individual students, the fact that no two students ever were alike or ever will be alike, furnishes a problem which never will be completely solved.

The fact that the psychology of the individual must be taken into consideration, and that the peculiarities of the individual must be learned, may be the reasons why F. S. Kedzie, School Science and Mathematics 5, 309-17, 1905, said the first laboratory experiments done by students must be more closely supervised by the instructor, than need be for the later ones.

Of course we know what L. C. Newell, School Science and Mathematics 7, 165-1907, means when he says "The beginner's work must be conducted judiciously for, to these students, chemistry is a new field, the student is appalled by the language, by the apparatus and by the materials. He is told to observe and interpret. Help must be brought to overcome the fright or rather the bewilderment."

If for these two very important reasons, the first few experiments in an elementary course should have closer supervision and more personal help rendered to the student, we could for the same reasons conclude that the beginning course should receive closer supervision than need be for the later courses.

Before we proceed further with a discussion of supervision and personal assistance, however, we should make careful distinction between supervision and personal assistance in regard

to laboratory work. Supervision may never take the form of personal help as far as manipulation of apparatus is concerned. It should often take the form of personal help as far as provoking thought on the part of the student is concerned. Supervision should always be close. Personal help should be rendered only when necessary to cause the student to put more confidence in his own resources. Supervision cannot be too close as long as it is for the purpose of ascertaining when the student's needs come and what they are when they do come. Personal assistance can be too great. It can be great enough to destroy a student's confidence in his own resources. It can be so great that the student will never think a thought of his own.

Since we have continually tried to put great emphasis on thought provocation, we ought to mention some conditions which are preliminary to the actual work with apparatus and materials. By all possible means we should arouse mental alertness on the part of the student. We do not mean, wake him up from sleep. This can be done with the very kind of noise which would interfere most seriously with his thinking chemistry. Starting automobiles just outside the laboratory not only interferes with his hearing the instructor but it makes him want to go somewhere. For this reason the laboratory should be situated in a quiet place or else provision should be made against all distracting noises. Too much conversation on unrelated subjects drives the students' minds into unrelated channels. Best instructors allow no whistling, singing, and talking in the laboratory excepting talking on the experiment which is being performed.

If preliminary precautions must be carefully observed in order to awaken the mind and get it started to thinking scientifically, and all noises, commotions, and conversations impertinent to the subject must be avoided in order to keep the mind on the subject; it is all the more important that the instructor makes his supervision of the work such that it does not side track the mind from certain definite lines of thought. These lines of thought should be scientific and logical. Of course they must be scientific if we are studying a science. They must be thoughts of chemistry if we are studying chemistry but that is not all that is meant by scientific. They should have a classified relation to each other and they should lead to truth. They should lead to truth in a logical way. Big thoughts do not suddenly break in upon small minds. They are built up by small ideas which have order in the structure.

This is no doubt the reason why L. C. Newell, SCHOOL SCIENCE AND MATHEMATICS 7, 165, 1907, says the student's mind, while he is operating in one direction must not be interrupted by irrelevant questions. He says that directions for preparing oxygen should not be interrupted by questions as to why use manganese dioxide or as to the principles underlying the collection of a gas over water. These should be asked in some other connection. Directions involving a continuous operation should not be split asunder by questions as to subordinate features of the manipulations.

This is what makes very close supervision on the part of the instructor important. To make directions in a manual suitable to all grades of students is impossible. The instructor must provide all that is necessary to guide the thoughts of each student or group of students under his supervision at the time. This means that he must keep close tab on what is going on in several places at one time.

Newell goes on to say that the instructor should not merely demand the what and the why concerning the observations and the final conclusions but he should suggest the line of observations, such as change of color, evolution of gas, change in temperature, formation of precipitate, etc., and give hints as to conclusions. He says also that most students like to perform experiments but few students like to do the original and independent thinking concerning the conclusion. It is necessary for the instructor to compel and guide the thinking by carefully devised questions.

After the student has completed an experiment, it is very hard for an instructor to satisfy or profit him by indicating that he has failed to observe or that he has failed to conclude aright. It is better if the instructor can see and bridge beforehand chasms across which the student has not eyes to see.

In order to keep the student thinking scientifically and logically as he proceeds with an experiment, the instructor must not only be able to see the line of thought from observations to conclusions and be able to avoid irrelevant ideas on the part of the student, but he must be able to provoke and relate thoughts which pertain to conclusions beyond those concerned with the experiment in hand. In the oxygen experiment he should not only avoid the branching off onto the principles concerned with the collection of gas over water, and hold the student to ideas concerned with reactions of oxygen with carbon, and oxygen

with phosphorous etc., which lead to conclusions concerning chemical properties of oxygen, but he should have the student thinking of how these particular methods serve as general methods of testing properties of any gases.

The young teacher who goes before his laboratory groups with the idea that he must guide the student's thinking rather than burden him with instruction is continually confronted with the problem as to what to do and say. His first idea as to the solution of the problem is: he should do and say as his own teacher did and said for him. But this may not be the thing for the student he is dealing with at the time. He needs to watch the student just sufficiently to find out what he is doing or is about to do, (not with a critical attitude), but by passing around and casually noticing. If the student is not taking hold at all, a good question to ask is, if he needs any help. This is a good question at any time when the student seems to hesitate. If this does not enable the instructor to tell what is in the student's mind, he should make some slight suggestions concerning the next step to be followed, carefully avoiding saying too much and depriving the student of the joy of thinking the thought which he should think. The instructor's suggestions should follow each other only as they are necessary to keep the student going. The instructor should keep hands off of apparatus at all times unless in a dire case of necessity in which he is convinced that the student should see some important thing done once in order to enable him to practice the same thing more effectively in the future.

This is in accord with much of what Segerblom, SCHOOL SCIENCE AND MATHEMATICS, 10, 18, 1910, says. He says the instructor should be careful as to what he says. He says there is danger of saying too much. He alsosays, "the instructor should maintain a scientific attitude of unprejudiced honesty of observation. The best time to do this is when helping the student in his experiment." We should say the best time to do this is when he is encouraging the student to help himself.

This method of conducting laboratory work might not be the method of getting things done most rapidly. But rapidity of turning out work is not the chief object of doing laboratory work. On very rare occasions the instructor may be justified in helping to rush through an insignificant step by helping to manipulate laboratory apparatus or giving specific directions in certain insignificant operations. As a general rule, however, at the end of a year's work the average student will have turned out as much

work (in number of experiments, etc.) by being encouraged to go to his own limit before receiving even helpful suggestions, as he would if he had been helped at every place in which opportunity presented itself.

If memory regarding procedure was the main consideration, the student could be depended upon to remember better what he thought out and did for himself than what he saw the instructor do, and so the latter half of his course of experiments would go faster after thinking his own way through the former half, than it would if he had let the instructor help him in even thinking what he ought to have thought for himself in the former half.

But memory is not the only mental attribute to be cultivated in laboratory exercises. In thinking over the many things that have been said on this as a general topic, we are reminded of what R. H. Bradbury, SCHOOL SCIENCE AND MATHEMATICS 15,782, 1915, said. In discussing methods of laboratory instruction he said "Make questions such as will call forth reasoning instead of memory. Men of judgment will get information from reliable sources and solve problems. Men of information and not power of reasoning will have a life full of errors."

Avoiding a life of errors is what education is for. So this philosophy is timely in whatever direction it may be applied. It is especially timely in the study and practice of chemistry. In practical chemistry it might be said that errors are more liable to lead to great disasters than in any other field of human endeavor. Therefore, of all of the subjects of learning, chemistry is the one in which the teacher needs to guide his students in laying foundations for scientific thought, if even it is at the expense of cultivating memories and accumulating funds of information.

OBJECTIVES OF HIGH SCHOOL CHEMISTRY.

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The definitions of main objectives of education has stimulated efforts to define social values for the various subjects of secondary education. In the field of chemistry as in other sciences a number of writers have made expression of social values or social objectives which should be made the goals of instruction. The im-

portance of these statements lies in the fact that for the most part they represent the most careful thought of the educational leaders in the field of curriculum.

The following list of objectives of chemistry represents a compilation from many sources. It is probably sufficiently comprehensive to include all the possible objectives which have been defined for this subject in the educational literature. Only such changes have been made in the original statements as were necessary to make them intelligible out of context. These are meaningful to the reader only if he is able to associate with the statements the types of subject matter and of class room activities which would be useful for their accomplishment.

OBJECTIVES OF CHEMISTRY (An eleventh or twelfth grade subject.)

a. To give to pupils a broad and genuine appreciation of what the development of chemistry means in modern social, industrial and national life.

b. To satisfy the natural interests in the things and forces of nature with which men are surrounded and with which they must deal: to give information which is interesting, purely for its own sake.

c. To provide opportunity for the student to become acquainted with the applications of chemistry to industry for the purpose of educational and vocational guidance and possibly to furnish a beginning of vocational training.

d. to develop such broad concepts and natural laws as the ultimate composition and indestructibility of matter, nature of chemical composition, interrelation of chemical elements, etc., to the end that science and reality may function in place of superstition and uncertainty in explaining natural phenomena.

e. To contribute such specific ideals, habits, and concepts as those of accuracy, achievement, persistency, open-mindedness, honesty, cause and effect, which are essential to the study of science.

f. To develop system, order, neatness, and possibly other attributes to the end that they will function in the ordinary affairs of life.

g. To afford in some measure an opportunity to show the importance of scientific research and to stimulate the spirit of investigation and invention on the part of the student.

h. To give to children full opportunity to indulge in the playful manipulation of chemical material in order that they may explore the world of reality as widely and as deeply as possible.

i. To provide opportunity for acquaintance with such applications of chemistry in public utilities in order that the student may more adequately fulfill the duties of citizenship.

j. To provide opportunity for acquaintance with such applications of chemistry as contribute to the maintenance of the health of the individual and the community.

k. To provide opportunity for acquaintance with the elementary laws of nature which aid in understanding those citizenship problems which arise in connection with such topics as utilization of waste products, elimination of smoke, pure foods, etc.

l. To make pupils able to read more intelligently and with greater interest, articles on chemistry in magazines and in scientific books of a popular character.

m. To give such training as will result in increasing respect for the work of recognized experts.

A STUDY OF MATHEMATICAL ABILITIES, POWERS, AND SKILLS AS SHOWN BY CERTAIN CLASSES IN PHYSICAL SCIENCE

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For many years, the country over, in the schools in which free election of courses is permitted, physics has been losing ground. In those schools where elections are limited to certain groups of courses, it is noticed that those groups which are free from physical sciences are the most popular. The per cent of students enrolled in public schools, taking physics, as shown by the reports of the Commissioner of Education for the years 1890 to 1922 was as follows:

Year	Per cent
1890	22.21
1895	22.27
1900	19.04
1905	15.66
1910	14.61
1915	14.23
1922	8.93

A canvass of the Junior College classes in physics in the University of Chicago, as to why they had not taken physics before reaching this level, reveals the fact that nearly eighty per cent of them had purposely avoided it because it "had a bad reputation," or because of fear of the difficulties it was supposed to offer. The remaining per cent had never had a chance to take it under favorable conditions.

Physics has suffered long enough from an inherited weakness. That there is a weakness is evident. The oft repeated confession, "I understand the physics, but I can't do the problems," is evidence enough of the source of the trouble. As long as teachers of physics are willing to go along their way, taking no account of the mathematical condition of their pupils and making no effort to apply remedial or corrective treatment, choosing rather to blame the student, or his former mathematics teachers for his short-coming, so long will physical science be regarded as a thing to be shunned, by a large per cent of pupils. How much more scientific is it for the teacher to attack the situation in a scientific manner and by making a diagnosis of the ailment, apply a remedy that will permanently cure the patient of the malady? It can be done. A very frequent testimony given in such cases is to the effect that more mathematics has been learned by taking physics than in the mathematics courses.

While such statements are perhaps extravagant, the fact remains that mathematics courses lack assimilative material, and with the physics motivation, much mathematics which has never reached the stage of real adaption becomes mastered.

The problem of the physics teacher with respect to mathematics is no different than his problem with the English situation. The teacher who is unwilling to apply corrective measures in English is failing as a teacher, even though he may succeed to a high degree in producing the adaptations desired in the subject matter of physics. The teacher of physics who is content to pass by the mathematical weaknesses of the fifty per cent or more of his class, and pitch his teaching so that it is within the grasp of less than half of the students, is failing to function as a real teacher and failing miserably as a physics teacher.

The data of this paper show that more than fifty per cent of the students investigated come with rather limited abilities in mathematics. The causes of these limitations is not the subject of this paper, nor is it the primary concern of the physics teacher when he has found such a situation. The data show moreover, the type of deficiency which is most prevalent and which must be corrected before success in physics can be achieved. It points conclusively to the need of re-teaching certain of the mathematical concepts. This may be done, of course, in a variety of ways. The teacher is conscious of the limitations of the class as a whole and of the particular individuals in the extreme cases. Success in this line will, and has, made an entirely different attitude on the part of the pupil toward the subject.

Any conclusions that may be drawn from this study are based upon a test of twenty-eight problems or tasks involving mathematics or mathematical understandings, powers or skills. These problems were selected to represent the type of mathematical ability that the course in beginning physics requires. Each student was given time to work all the problems he was able to work. The interpretations are based upon what he did solve and solve correctly. No inference is made that he can or cannot solve others.

This study is an attempt to determine from the available data some light on the following:

1—Of which of the mathematical processes used in the physical sciences, do the students coming into the classes lack command?

2—Of which mathematical processes used in science, do the students coming into the classes have a command?

3—To what extent do these pupils have command of the various mathematical processes?

4—Is there any relation between the ability shown and the number of years of mathematical study?

5—Is there any relation between the ability shown by classes taught under a mastery technique and those taught by other methods?

The study is based upon the results obtained from two classes (46 students) of the University High School, starting physics in October and two classes (45 students) from the Junior College of the University of Chicago, beginning physics at the same time. It is well to call attention to the fact that the number of years of mathematical preparation varies in both the high school and college groups. The age of the students of the high school group varies from 13 years 9 months to 17 years 10 months, with an average age of 16 years 4 months. The ages of the junior college group vary from 16 years 5 months to 28 years 9 months, the average age being 19 years 10 months. The study, in so far as points 1, 2 and 3, above is concerned, does not need to take any concern of these things. It may be well to have these differences in mind in interpreting the rest of the study. The relative importance of the mathematical adaptions and powers is not in question. All of the processes tested are in use—many of them in constant use—in physics, and ability to use them must be possessed or be achieved before physics can be successfully mastered. The student who "Understands physics, but cannot do the problems" is misleading himself. Thorough understanding of physics involves an ability to sense the principles in the problematic situations of the environment and to solve them. Indeed much of the assimilative material from which real understanding comes, is to be found only in problem situations. It is entirely possible that much good material may be positively inhibitive through no fault of the material in itself, but because of mathematical difficulties encountered in its assimilation. The corollary of this is that much lack of assimilation is due to mathematical weakness.

The weakness may be, lack of understanding of fundamental mathematical ideas, inability to perform mathematical operations, or may be traced to inaccuracy or gross carelessnes. Whatever the cause, it is of vital importance that the teacher

of physics identify the trouble and apply corrective treatment, if the adaptions contemplated by his course are to be realized.

Let it be understood that this paper has no desire to place any blame upon mathematics teachers, or to criticise any method of instruction that may or may not have been used. It is an attempt to learn the situation with respect to the mathematical condition which prevailed at this time, and at others as will be shown later, in order to determine upon the kind and amount of corrective teaching required.

A copy of the test questions follows:

1. A boy measures the radius of a circle and finds it to be 24.32 inches. The exact radius is 24.30 inches. (a) How much error did he make in measuring? (b) What is the per cent error in his measurement? (c) What would be his percent error in the area of the circle, if he used his measurement instead of the correct radius in calculating the radius?

2. Show by a bar graph, using cross-ruled paper, the relations given in the table below:

Number of Tons of Coal Used in a Factory.

January	1,500	July	1,200
February	1,400	August	1,250
March	1,250	September	1,600
April	1,200	October	1,400
May	1,100	November	1,350
June	1,100	December	1,300

3. (a) Make a line graph to show the relationship expressed in the equation: $C=(-F-32)\ 5/9$, plotting the corresponding values of 80, 70, 90, 100. Let the values of C be laid off horizontally and the values of F vertically, the distance between two heavy lines being equal to 10 degrees. (b) What is the value of F when $C=95$; as shown on your graph?

4. Write the reciprocal of 6/9; and (b) of 2.

5. 40% of the boys in a class is 4% of the girls in school. There are 400 girls in school. How many boys are there in the class?

6. Multiply .039 by 4.60.

7. Divide .0179 by .000475.

8. .04 is .4% of what number?

9. If 4/9 of a yard of cloth costs 14/27 dollars, what will 5/8 of a yard cost?

10. In the equation $S=\frac{1}{2}/gt^2$, $g=32$, and $t=6$. Find the value of S.

11. In the equation, $V=\sqrt{2gs}$, $g=32$ and $S=800$. Find the value of V.

12. Express 3/17 as a decimal.

13. If $W=VA$ and $A=V/R$, what is the value of W in terms of V and R?

14. Simplify the following expression:—

$$a+b-(c-d)+a-(b+d)+b+c-d.$$

15. What is the value of F in the equation: $I/F=I/D+I/D'$?

16. The radius of a sphere is 6 inches. (a) What is the diameter? (b) What is the area of a section through the center? (c) What is the area of the surface of the sphere? (d) What is the volume of the sphere?

17. What is the capacity of a box 8.03 ft. long, 6.48 ft. wide and, 4.2 ft. high?

18. The distances which two opposing football teams gained by the use of the forward pass were inversely proportional to the score. The game ended 21 to 6 and the sinning team made 22 yards on forward passes. How many yards did the losing team make on forward passes?

19. There are 39.37 inches in one meter. One meter equals 100 centimeters. How many centimeters are there in 24.35 inches?

20. An aeroplane flies 2000 miles in 16 hours and 23 minutes. What is the average speed per hour?

21. What is the capacity of a cylindrical vessel 50 centimeters in diameter and 75 centimeters deep?

The first table will show a general summary of the test results as made by the two groups. It is self explanatory.

TABLE 1.

	U. High	J. Coll.
Total number of solutions 28 problems X number of students	1288	1260
Total number correct in method	700	670
Total number correct in both method and accuracy	517	517
Per cent correct in method	53	53
Per cent correct in both method and accuracy	40	45
Per cent of accuracy	74	77

TABLE 2.

Composite Score of Problems Correct as to Method

	1a	1b	1c	2	3a	3b	4a
U. High (46)	38	13	3	38	24	26	14
J. Coll. (45)	36	17	11	18	11	2	22
Totals	74	30	14	56	35	28	36
% Correct	81	33	15	61	38	31	4

	4b	5	6	7	8	9	10
U. High	13	28	45	35	16	19	37
J. Coll	19	30	36	24	10	14	22
Totals	32	58	81	59	26	33	59
% Correct	35	64	50	66	29	36	6

	11	12	13	14	15	16a	16b	16c
U. High	40	32	32	29	15	37	9	1
J. Coll	42	38	32	36	11	38	24	8
Totals	82	70	64	65	16	75	33	9
% Correct	90	77	70	71	17	82	36	9

	16d	17	18	19	20	21
U. High	1	43	16	34	39	25
J. Coll	5	43	19	39	41	21
Totals	6	86	35	73	80	46
% Correct	7	94	39	88	88	50

TABLE 3.

Composite Score of Problems Entirely Correct (Method and Accuracy)

	1a	1b	1c	2	3a	3b	4a	4b
U. High	37	9	2	42	23	14	14	13
J. Coll	36	17	6	13	6	2	22	19
Totals	73	26	8	55	29	16	36	32
% Correct	81	29	9	60	32	17	40	35

	5	6	7	8	9	10	11	12

U. High	23	38	19	3	13	33	18	24
J. Coll	30	30	18	9	10	18	21	35
Totals	53	68	37	12	23	51	39	59
% Correct	59	74	41	13	25	56	43	65

	13	14	15	16a	16b	16c	16d	17
U. High	27	17	5	37	9	1	1	31
J. Coll	31	27	8	38	21	8	1	41
Totals	58	44	13	75	30	9	2	72
% Correct	64	48	14	82	33	10	2	79

	18	19	20	21
U. High	15	19	20	7
J. Coll	19	35	26	21
Totals	34	54	46	28
% Correct	38	59	50	30

Out of the twenty-eight problems, in the High School we find a median score of 10.78 on the entirely correct basis. In the Junior College group the median is 11.6. The range of the scores in the first case, based on per cent, is 61 points (7—68%). In the latter, it is 66 points (14—80%).

Table 4 is arranged to show the type of difficulty occuring. The first column gives the mathematical process involved and is arranged in the order of decreasing difficulty for Junior College Students. The second column gives the per cent of students entirely correct. The numbers in parenthesis, following the per cent, give the order of difficulty.

TABLE 4.

Mathematical Process	Per Cent of Coll. Students Correct
Finding the value of F on plotted graph. Given $C=(F-32)5/9$	4 (1)
Volume of sphere, given radius	10 (2)
Area of surface of sphere, given radius	17 (3)
Simple fractions (mental arithmetic)	19 (4)
Percentage (using decimals)	22 (5)
Per cent error in area, given error in radius	24 (6)
Making line graph, given: $C=(F-32)5/9$	24 (6)
Value of F in equation: $1/F=1/D-1/D^1$	24 (6)
Calculating per cent error	37 (7)
Making bar graph from figures given	39 (8)
Writing reciprocal of 2	41 (9)
Inverse proportion	41 (9)
Capacity of Cylinder	45 (10)
Value of S in $S=1/2Gt^2$	48 (11)
Reciprocal of 6/9	48 (11)
Simple division of decimals	52 (12)
Diam. of circle, given radius	52 (12)
Percentage, double use in single problem	64 (13)
Substituting for A in $W=VA$, where $A=V/R$	69 (14)

Simple subtraction	78 (15)
Multiplication of two decimals	78 (15)
Removal of parenthesis and simplifying	78 (15)
Changing common fraction to decimal	82 (16)
Division of whole number by mixed number	85 (17)
Conversion of inches to centimeters, given conversion values	85 (17)
Substituting given values in, $V = \sqrt{2gs}$	91 (18)
Volume of a rectangular body	95 (19)

It is a striking fact that not one of the twenty-eight problems was solved correctly by all of the forty-five pupils.

For purposes of comparison of this Junior College group and the High School group, Table 5, shows the order of difficulty for the groups. The numbers refer to the problems. The arrangement is in the order of decreasing difficulty.

TABLE 5.

Junior Coll.	High School	Junior Coll.	High School
3b	16d	7	12
16d	16c	16b	13
16c	1c	5	3a
9	15	13	——
8	16b	——	7
1c	4b	1a	10
3a	1b	6	16a
15	4a	14	2
1b	8	12	1a
2	18	16a	19
4b	9	19	20
18	21	11	11
21	3b	20	17
10	5	17	6
4a	14		

The horizontal line in the two columns indicates that all problems above it were solved by fewer than 75% of the students.

In the Junior College class, 68% of the problems were solved correctly by 75% or less of the students. In the High School class 64% of the problems were solved correctly by 75% or less of the students.

The problems which offer difficulty to both High School and College classes, and upon which there was less than 75% accomplishment are: 3b, 16d, 16c, 9, 8, 1c, 3a, 15, 1b, 4b, 18, 21, 4a, 16b, 5, 13.

Problems which 50% or more of the High School students handled correctly, but not handled correctly by 50% of the J. C. students are: 3b, 3a, 2, 21, 10.

Problems which 50% or more of the J. C. handled correctly, but which were done correctly by less than 50% of the High School students.

It is of interest to note the type of thing which is of frequent use in physics, in which the classes used in this study show

weakness. These are listed in the order of their decreasing difficulty as shown by both J. C. and H. S. classes. The list includes only those which were solved correctly by less than 75% of the two classes.

16d..........Determining the volume of a sphere, given the radius.
16e..........Determining the surface of a sphere, given the radius.
1c..........Determining the % error in two dimensions, given the % error in each.
15 ....Value of F in equation, $1/F = 1/D - 1/D^1$.
8 ....Per cent one decimal is of another.
9 ....Simple fractions—Mental arithmetic type.
1b..........Per cent error, given correct and incorrect measurements.
4b..........Writing reciprocal of 2.
16b..........Area of circle, given the radius.
18 ....Inverse proportion.
4a..........Writing the reciprocal of 6/9.
3a..........Making line graph from relation, $C = (F - 32)5/9$.
21 ....Capacity of cylinder, given diameter and height.
2 ....Making bar graph from given data.
5 ....Percentage, double use in single problem.
7 ....Division of one decimal by another.
13 ....Substitution for A, in equation: $W = VA$, where $A = V/R$.
14 ....Removing parenthesis and simplifying.

Putting aside such suggestions as to whether these are representative weakness or not, whether the given test is a valid test of mathematical abilities, and which of the processes is most important, the fact remains that for these groups, these are at least some of the things that must receive attention before facility and surety can be expected in those physics situations in which these processes are found.

In this connection it is interesting to compare the results of a similar study made by Mr. Chas. J. Pieper in 1923, and applied to all science classes in the Univeristy High School. This study shows that the type of mathematical process most frequently giving difficulty to the physics students of that year were, with two exceptions, the very ones identified in the study of which this paper deals. The order of difficulty moreover, was found to be practically the same.

The type of mathematical process handled correctly by more than 75% of the Junior College group, arranged in the order of decreasing difficulty follows:

(1) Subtraction of decimals.
(2) Multiplication of decimals.
(3) Changing common fractions to decimal form.
(4) Diameter of circle when radius is given.
(5) Reduction of inches to cm., reduction factor is given.
(6) Division of whole number by mixed number.
(7) Capacity of rectangular box.

The correlation between this list and the same arrangement

for the high school group is high. The group in physics, tested in 1923 has the same order for the 75% or better score.

The following table (Table 6) shows the relation between the number of years of mathematical study and the mathematical ability shown in the test.

TABLE 6.

High School Students

Years of Mathematics	No. of Students	Method No. of Probs.	O. K. Per Cent	Meth. & No. Prob.	Accuracy %
2	13	164	45	121	33
2.5	2	27	48	23	41
3	24	383	57	276	41
4	7	126	64	100	51
		Junior Coll. Students			
2	18	213	42	174	34
2.5	5	63	45	50	36
3	11	189	60	159	50
4	9	171	68	151	60
4.5	2	37	66	33	58

While the number of cases is not sufficient for a valid conclusion, it would seem from the data, that it is probable that mathematical study has an effect in improving the situation. It is hardly probable that mathematics teaching beyond the second year has contributed directly to the understandings needed in the solution of the problems of the test. What has happened is that mathematics has been met in more situations and a facility of thought and manipulation has resulted. In just this way may we expect physics to improve the mathematical situation if properly managed. This is probably the first place in the high school life of the pupil that the functional use of mathematics has come into full play. Small wonder is it then that the student "learns more mathematics in physics than in all his mathematics courses."

It will be noted from the above table, that the degree of accuracy seems to increase with the years of mathematical study. The case of the two students coming with more than four years of training should be disregarded, as one of them has since been identified as an extremely careless and unreliable student.

The physics teacher's job is to give opportunity and abundant opportunity for the assimilation of the mathematical processes which are apparently only in the process of assimilation in

so many of the cases in the mathematics courses. The teacher who neglects this opportunity, or who refuses to "do the mathematics teacher's job for him," is failing not only as a teacher, but he is failing to strike at the very core of the matter of the unpopularity of his subject.

If we are correct in assuming that the High School pupils tested have been taught under a technique appropriate to the science type, and with a very few exceptions this is true, and if we may assume that the students of the Junior College group have not been so taught, the results of teaching under mastery technique are disappointing. (See Table 1). The two groups show the same per cent of correct answers in method. This would seem to indicate the same degree of understanding. The College group makes a slightly better showing when both method and accuracy are taken into account, as the per cent of accuracy is a bit higher with this group.

It may be unfair to compare these two groups in this way. The age of the college students is greater and consequently their mathematical experience is presumably more mature. Again it must be remembered that a college group such as this, probably represents the best of the scholarship product of the several schools represented. Many of these give evidence of being "lesson learners" and are probably notable examples of the transfer type. On the other hand, it must not be forgotten that the college student is farther away from the teaching of these principles and has had more chance to become rusty.

It seems from a consideration of the data, that we may safely draw the following conclusions from the study:

(1) Pupils come to physics with very marked inabilities to handle the mathematics of physics.

(2) The type of inability seems to be fairly uniform in both High School and Junior College classes.

(3) The type of inability can be pre-determined, by adequate testing, for both the individual and the group.

(4) There is probably a close correlation between mathematical ability and the number of courses in mathematics covered.

(5) There does not seem to be any basis, in so far as these data show, for assuming that any one type of teaching technique produces a superior type of ability.

(6) The duty of the physics teacher is clear. (1) Identifica-

tion of the mathematical difficulties. (2) Re-teach until he is sure of assimilation of the mathematics involved before attempting to give the physics using these principles. (3) Being sure of the mathematical ability, the science teacher's real opportunity to teach his subject is in teaching the physics in the problematic situation. It is well to remark that it requires a very special ability to apply science in the problematic situation even after the mathematical process is sure.

(7) The bad reputation that physics and the physical sciences has as being difficult, may be materially modified by giving attention to the root of the real trouble.

(8) Experience teaches that the instructor can meet the situation with very little effort. A bit of propaganda on the idea of mastery, a clear picture of the mathematical condition of the student with respect to that which the course requires exhibited to the individual student, will convince him of his limitations and usually get from him a very favorable response. The writer feels that he has been at least fairly successful in making problem solving in physics a pleasure for the student, rather than the usual dreaded procedure. He feels sure that he has changed the attitude toward the subject in no small degree and has reduced the number of fatalities traceable to this cause by a very marked percentage.

SOME COMPARISONS OF BIOLOGICAL SCIENCE TEACHING IN THE SECONDARY SCHOOLS OF ILLINOIS AND THE UNITED STATES AS A WHOLE.

By George W. Hunter.
Knox College, Galesburg, Ill.

In the October, 1923, issue of this Journal there was published the findings of a committee making a report on a one year fundamental course in biological science. These fundamentals, 98 topics, were sent out to the high schools of the state with a request that they indicate the topics on which they place emphasis in their courses in general science, biology, botany, zoology, physiology and agriculture.

This questionnaire was answered by 115 schools and a tabulation of these answers was given in the report of 1923. It appeared that a very large number of the fundamental topics cited by the committee were made use of in the various schools. 84 topics out of the 98 given were used by 90% of the schools and only 3 topics given were not used by more than 33% of the schools.

In this article I wish to make certain comparisons obtained from the reports given by schools last year compared with the results of a questionnaire recently put out to typical high schools in all parts of the United States.

A thousand copies of this questionnaire were sent out to representative high schools practically all in cities of over 10,000 inhabitants. Five hundred of these schools were taken from a similar list to which I sent a questionnaire in 1908. The findings of this original report appeared in "School Science and Mathematics" in Vol. 10, 1910 under the title of "The Methods, Content and Purpose of Biological Science in the Secondary Schools of the United States." Nearly 400 replies were received from the second questionnaire, and these answers, which represent a cross-section of teaching conditions in the better type of high school in the United States, show the following points rather definitely:[1]

First. In comparing a group of schools with a like group fifteen years ago it was found that there are actually more courses offered in sciences than fifteen years ago. About 10% more as a matter of fact. Book courses have decreased, while hours devoted to laboratory science have increased.

Second. The number of students taking science has relatively greatly increased.

Third. That, according to statements made by teachers, there is much greater interest in science on the part of students. Some typical reasons for this increase in interest are as follows:

West Division High School, Milwaukee, Wis.

"General Science—arouses interest in science, teachers elementary principles.

2—Zoology and Botany given at an age when living things appeal.

3—Chemistry } more abstract. In my opinion Chemistry should
4—Physics } follow Physics, because much of it depends upon an understanding of Physics."

Humboldt High School, St. Paul, Minn.:

"General Science will awaken interest in any or all other sciences, result in intelligent selection. Biology is a good prerequisite for home economics and also for chemistry."

St. Cloud High School, St. Cloud, Minn.

"Hygiene, so many students drop out in 8th grade; general science and general biology to arouse interest and develop interest. Physics comes closer to math. which students had first two years."

Phillips High School, Birmingham, Ala.:

"Pupils are naturally more interested in the phase of science which is most closely related to their everyday lives(General Science), and living things (Biology), and in case pupils do not continue on through the whole four years, General Science and Biology furnish the most useful knowledge."

Oshkosh High, Oshkosh, Wisconsin:

[1]The findings from this questionnaire appear in the May and June numbers of the School Review.

"The teachers of chemistry and physics say they believe the students gain considerable from the earlier sciences both in subject matter and laboratory technique. They are sure biology is a great help."

Mt. Vernon High, Mr. Vernon, N. Y.:

"They gain a desire for more science work. They learn how to handle simple apparatus. They experience the joy of finding things out for themselves so that many look forward to a later science course. They learn how to write out an experiment in good form. They learn how to keep a notebook and value it as a means of study. It is difficult to tell just how much this counts later on but I think it must have its effect":

Fourth. More students are interested to take advanced science in the latter years of high school because of the interest aroused in general science or biology.

Fifth. There is a better correlation in courses of high school science. There is more coöperation on the part of different department heads who work out courses and who work out sequences in courses, irrespective of the attempted domination of college or university. There is a distinct tendency in some parts of the country to correlate social science with general science or with biology. A few quotations follow which show what progressive teachers in different parts of the United States have to say on this subject:

Pasadena High School, Pasadena, Calif.:

"The reasons are very well stated in the N. E. A. Committee report. The General Science has been taken by many heretofore but not required as the Junior High was organized in only one district. Hereafter it will be broadened to include citizenship and will be called Civic Science."

LaSalle-Peru Twp. High, Peru, Ill.:

"Botany and Zoology have been combined into Biology. Course in General Science has made the relations of other sciences clear. Course in agriculture has shown the need of the other sciences. The teachers also co-operate more."

McKinley High, St. Louis Mo.:

"More closely united. But only in the respect that in all sciences the unifying element is now more the 'pupil's interest' rather than the unity of the science itself."

Canaan Twp. High, Creaton, Ohio:

"Yes, more closely related. The continuity of nature is emphasized to a greater degree in recent text books. Also a good modern teacher will emphasize this feature."

Springfield Twp. Centralized, Ellet, Ohio.:

"Science courses in general are now closer related because of the present educational trend to interrelate all subjects of the curriculum as much as possible."

Ballard High, Seattle, Wash.

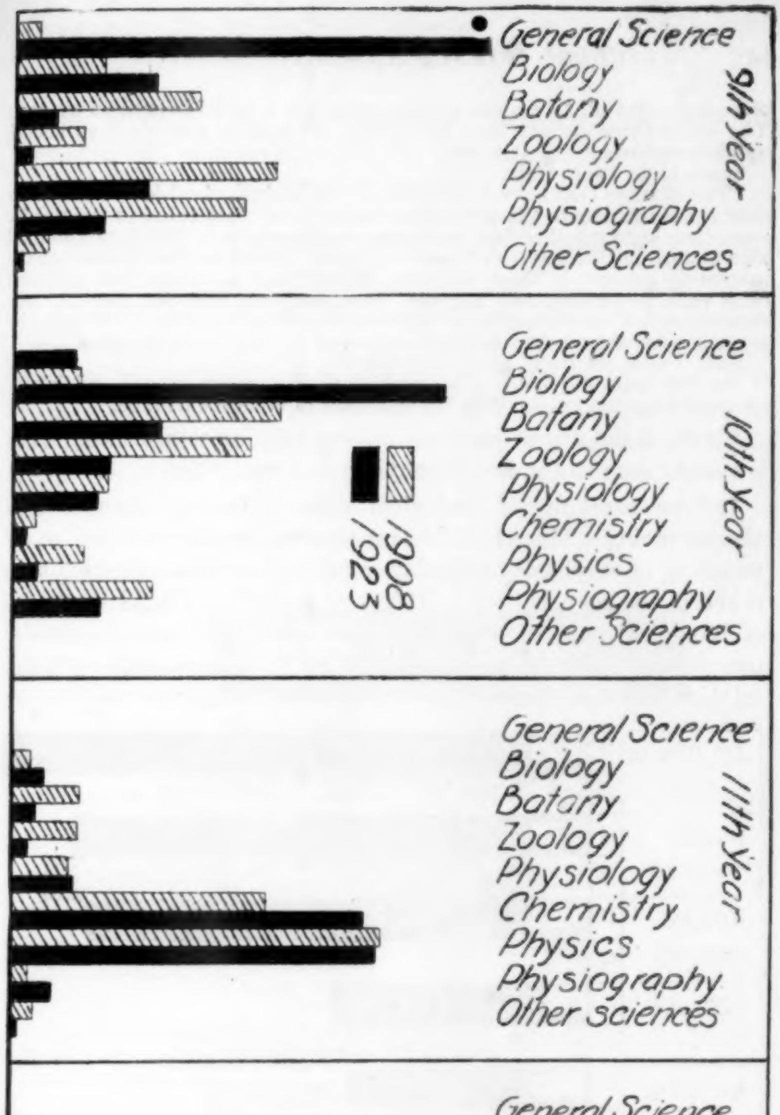
"We emphasize sequence. There is a closer interest and cooperation between the science teachers than formerly. The science teacher more than formerly sees good in the other science instructors' subjects."

Riverside High School, Milwaukee:

"The sciences have more unity. There is less of the separate science and more of science as a whole. I believe there is more interest taken in science. Students are realizing that science is essential to a well rounded education. The more science of all kinds, the better is he or she able to successfully teach."

Central High School, Cape Girardeau, Mo:

"I am convinced that the social and economic values of sciences are



A comparison of science conditions in 4 years high school, 1908-1923.

often lost sight of. We make biology as nearly a social science as we can. The other three do not lend themselves so readily, but we give social values emphasis."

Santa Cruz High, Cal.:

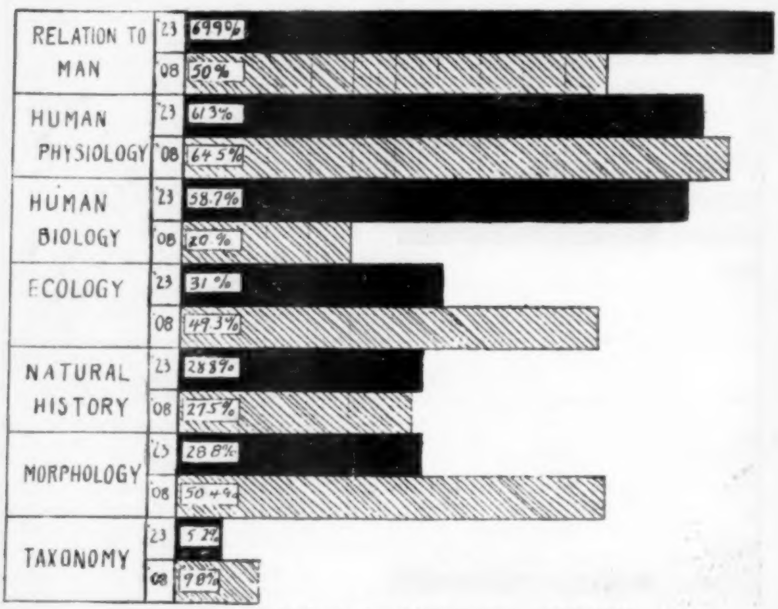
"The changes that have taken place in the biological subjects have been only those relating to the selection of subjects of most value to the pupils regardless as to whether they are to go to college or not. The fundamental idea underlying the selection has not changed. There has been a constantly increasing interest in these subjects. Seven years ago there was but one class each in biology and hygiene, now there are fourteen classes. No complaint has ever come from the state or other university, though the work has never been planned with reference to other requirements."

East Technical High, Cleveland, Ohio:

"In the main our courses are shaped to meet the personal and future needs of students rather than the demands of college entrance."

Sixth. A definite sequence in science is being established. This is clearly seen in the accompanying diagram.

In the teaching of biological subject matter changes are also occurring. There is, at the present time, a definite change in weighing of emphasis on fundamental topics. This question was asked of the schools both in 1908 and in 1923. "On what phases of biological subject matter do you place the most emphasis; morphology, physiology, natural history, taxonomy, ecology, relations to man, human biology? Why? A glance at the ac-

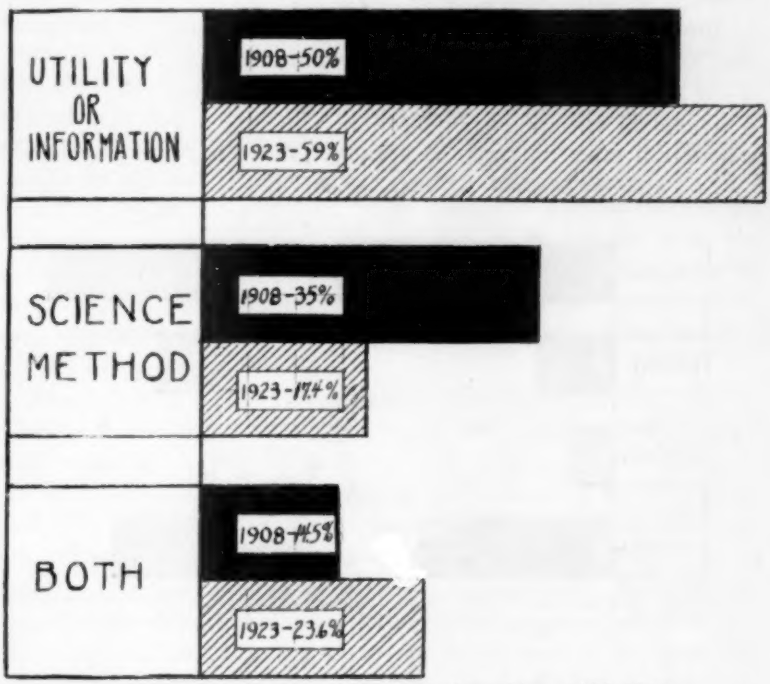


Emphasis on biological subject matter, 1908-1923.

companying diagram shows that there is a growing tendency to utilize subject matter most worth while from the standpoint

of the student. The "psychological" approach instead of the "scientifical" approach is evident. Less emphasis on morphology or physiology as such; more emphasis on the applications of biology as such and particularly more emphasis on health teaching appears to be the key note of work in elementary biology today.

Another question was asked which was intended to discover the methods in teaching. It read: "Should a course in elementary biology in the high school place more emphasis on training in science method or should the utility or informational values be given first place?" In this comparison there is seen a change from the methodology of 1908. There now is less emphasis on the formal "method of science" as such. There is more effort on the part of teachers to make use of children's interests and instincts. The notable net result is better teaching.

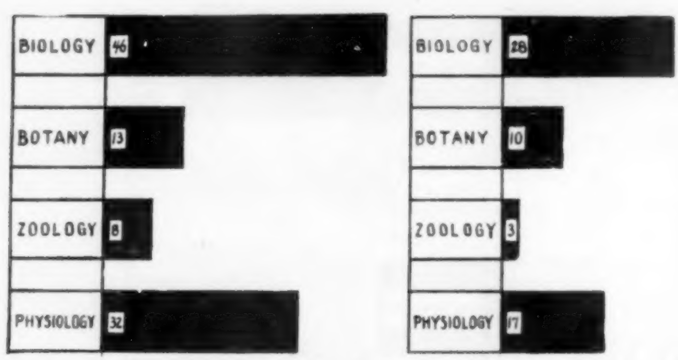


Comparison in methods of biological teaching, 1908-1923.

In comparing certain obtained results from this questionnaire with figures obtained from the questionnaire sent out to the Illinois teachers of biology, certain rather striking tendencies are shown.

Using the 115 schools as a basis of comparison with 386 selected schools from all parts of the United States, we note, first, that in 1923 Illinois was apparently teaching proportionately fewer courses of general science than is the United States as a whole. Second, that there were proportionately fewer courses of biologic science taught in Illinois than in the United States as whole; that there were proportionately a greater number of separate courses in botany, zoology, and human physiology in Illinois than in the United States as whole.

Why is this? If we turn to the report of the committee on fundamentals we see that 84 topics out of the 98 were made use of by 90% of the schools. These topics are not restricted to any one subject but are often touched on in the same school in general science, biology, botany, zoology or physiology. If we analyze these 98 topics from a standpoint of topics in courses of biology, botany, zoology and physiology we see that they may be grouped as follows: 46 biological; 13 botanical; 8 zoological and 32 physiological. If we take the topics selected by over 90% of the high schools we find that there are 28 biological; 10 botanical; 3 zoological and 17 physiological. You remember that in 115 schools 35 offer biology; 73 botany; 66 zoology; 53 physiology and 53 general science. A comparison of the two graphs shows



Emphasis on topics in Illinois high schools answering the questionnaire of 1922 on a one year fundamental course in biological science.

that the greatest number of topics taken are really biological and physiological although in terms of courses the state professes to teach more botany and zoology than biology and physiology as such. It is interesting then to inquire why Illinois' teachers select as fundamentals a very large percentage of topics

in general biology and physiology but on the other hand teach proportionately more courses in botany and zoology. Let us attempt to analyze this apparent inconsistency.

There are several factors at work here. First is the training of teachers. The University of Illinois and the University of Chicago represent two of our more conservative types of institutions considered from the standpoint of the teaching of biological science. In neither institution is there organic interrelationship between the departments of botany, zoology and physiology. As a former graduate student in one institution and a teacher sending graduate students to the other I can personally testify to this. I remember when I started my teaching at the Hyde Park High School twenty odd years ago that I was hired to teach zoology and I would have felt aggrieved had I been asked to teach any other subject in the school curriculum. My training would not have enabled me to do it. The University of Chicago prided itself on thoroughness in one line of work in one department. As a research student working for my doctorate I was training along certain lines only. Today at the University of Illinois students working for a higher degree specialize to an almost unbelievable degree. A Ph. D. from some of our universities today are allowed to major in one department and then take minors in other branches of the department. This results in a disproportionate view of a given branch of science that is deplorable from the standpoint of the secondary school teacher. Unfortunately most doctors of philosophy are research men and are teachers only by courtesy. The research mind and that of the teacher do not often go together.

The difficulty in this water-tight scheme becomes most evident when the secondary school teacher starts his or her teaching after such training in the university. He does not know the good points of the other departments and hence is not able to co-operate properly with other departments when he becomes a secondary school teacher. At the university he is not shown how to make use of the research work of the psychologist, the educator and the clinic. In his attempt to become acquainted with the facts and method of pure science he loses sight of the goal, his own preadolescent students. But the real teachers must make use of all these by-products of the laboratory if they are to become of real service in the secondary school. And in this respect the graduate schools of pure science in a university fail to train a teacher for secondary work.

But to come back to our findings. The indication seems to be that whereas teachers are putting their emphasis on teaching biological and physiological topics they are as a matter of fact giving courses in botany and zoology. These courses are proportionately greater in number than we find in other parts of the United States thus indicating a breaking away from the regular sequence. May it not be a combination of the training they have received in a university together with a possible artificial pressure on the part of the university toward courses in botany and zoology? This second factor may be noticed in a glance at the present high school manual giving standards and general recommendation for accredited schools. The manual of June, 1922, indicates that botany and zoology are acceptable units; it devotes three and a half pages to a botany syllabus, three pages to a physiology syllabus, and three pages to a zoology syllabus but gives three lines to the statement that, "For a good course in general biology conducted as a laboratory science for not less than 36 weeks, one unit of credit is allowed. This work may be offered as a half year each, of botany and zoology." Knowing secondary school teachers as I do (having been one myself for over twenty years) I can see that the young teacher with no definite guide for a course in biology but a very definite outline in the other courses would naturally tend to give such courses as directions were given for. And when we remember that the annual turn over in the high school is very great, amounting in many schools to from one-fourth to one-third of the total corps of teachers in a given school, we can see there is very definite pressure brought to bear upon the young teacher to give a course in botany or zoology rather than a course in biologic principles for which he or she has no directions.

A third factor is what seems to me a discrimination on the part of the University of Illinois against schools which give courses in biology rather than courses in botany or zoology. The high school manual just referred to on pages *four and seven* details a list of units acceptable for admission to the undergraduate colleges of the University. The 15 units contain 6 units of prescription which read as follows:

List A.

English (composition and literature)	3 units
Algebra	1 unit
Plane geometry	1 unit
Physics, or chemistry, or botany, or zoology, or physiology, or physiography, or general science, with laboratory work	1 unit
Total	6 units

The additional 9 units are taken from lists B. & C. and in neither of these lists does the term "biology" or "elementary biology" appear.

Again speaking as a secondary school teacher—not as a college man—I can testify that I know of many principals and superintendents not much interested in science or not knowing the changes occurring in modern biological teaching, who would not allow a progressive teacher to introduce a course in principles in biology because the course was not allowed as an entrance unit for the University of Illinois. For as I understand the present situation, biology is relegated to the limbo of list C. along with music, drawing, domestic science and manual training—an obvious insult to a course in pure science.

Is there any cure of this existing situation? It does not lie in the reports of committees. Better men than I have been at work in the state for the past twenty years and their efforts in the form of reports and syllabi lie buried in annual conference or meeting proceedings. No, the progress will not come through committee reports. But how will it come?

Firstly. Progress will come only through the establishment of schools of education with practice laboratories in which educational experiments may be tried out. Furthermore, the schools of the state must themselves be able to try out these experiments. The worst thing for a state system of education is a static, unbending system in which no allowance is made for individual conditions or environment or school life. There is much need for us to know what is best to teach in science to preadolescent and adolescent. We are prone as teachers to be static, not dynatic; to fear a change, not seek a change. This great state of Illinois should lead in opportunities for teachers to learn *how* to teach rather than to show them *what* to teach. The children with whom they are associated, the environment in which they live, the conditions which are existing are the factors which answer these questions—*what* to teach in science.

Secondly, changes may be brought about through the awakening of the teachers in public high schools that they are servants in a democracy to the people of that democracy. And as such they are responsible to the tax payers, the common people in that democracy. When the public high school finds itself and resolves to teach to its children the material of most worth to them as future citizens and homemakers, then the problem of how to teach and what to teach will be solved to the lasting good of those for whom the schools are built—the children of our state.

THE TREND OF GENERAL SCIENCE.

By Benjamin C. Gruenberg,

Managing Director, American Association for Medical Progress; formerly head of Science Department, Julia Richman High School, New York; head of Biology Department, Commercial High School, Brooklyn, N. Y.

and

Frank M. Wheat,

Chairman Biology Department, George Washington High School, New York; and Instructor of Biology, New York University, New York City

Most people want something fixed and enduring to cling to, as a basis and guide in the difficult situations of life. But since the teachings of science have for a long time implied that nothing whatever endures except change, it may not be unreasonable to hope that in increasing numbers the teachers of science will come to accept a moving equilibrium as a satisfactory basis for adjustment and guidance. At any rate, the teaching of science is itself in a changing state that defies rigid definition and demands rather nimble stepping on the part of the teacher. A questionary study just completed shows hardly more than this: General Science is in process of change.

The questionary was sent out shortly after the winter holidays (1923-24) to two-hundred teachers in various parts of the country. Eleven papers were returned by the post-office. There were received 104 replies, of which a number came from schools that do not offer courses in General Science; some from teachers who were no longer teaching the subject but who kindly volunteered to answer certain questions on the basis of previous experience and observations; two sets of replies referred to normal schools; a few referred to groups of three or more schools under the same supervision; and, the replies for certain of the questions were omitted in many cases. As a result of these irregularities, the number of replies was not the same for each question; and a statistical analysis would hardly be warranted because of the small numbers involved. We are nevertheless warranted in drawing certain conclusions regarding some fairly well marked tendencies.

The questions were divided into five groups, as follows:

A On the status of science in the school

B On the factors involved in the choice of material

C On methods
D On text books
E On illustrations

The returns are presented and discussed below in the sequence of the questions.

GROUP A. ON THE STATUS OF SCIENCE IN THE SCHOOL

1. *In what grade(s) is General Science taught in your school?*

Of 79 replies to this question 49 are from schools that offer G. S. in the ninth grade only; 6 from schools that offer it in the eighth grade only; and one from a school that offers it in the tenth grade only. The rest (23) carry "general science" through two or more grades.

The Distribution of General Science by Grades

GRADES	NUMBER OF SCHOOLS[1]
10 only	1
9 only	49
8 only	6
9 and 10	2
8 and 9	8
7, 8 and 9	6
7 and 8	3
6, 7 and 8	3
6, 7, 8, 9	1
No answer	5
	84

We get the impression that the preponderance of 9th grade General Science corresponds to a tendency to adopt the general plan recommended by the N. E. A. Committee on the Reorganization of Science in Secondary Schools (U. S. Bureau of Education, Bulletin 1920, No. 26). At the same time there is a growing demand for more serious organization of the nature and science material in the lower grades; and a tendency to develop "science" as *a continuing element of instruction,* parallel with language, mathematics and social studies.[2]

2. *Is G. S. required or optional?*

Of ninety schools (or school systems) four failed to reply, or otherwise to indicate the status of the subject. General Science is required in over 54 per cent (47 replies) and optional in the rest (39). The total (90) includes a few cases in which

[1]Replies covering school groups or systems have been treated as single units comparable to single schools in other systems.

[2]A supervisor of junior high schools in a state department of education, after a study of the curriculum in grades five to nine of fourteen municipal systems, recommends "that the general science of the ninth year shall be preceded by two periods at least of elementary science in the seventh and eighth years," in the hope that science may be ultimately made "one of the constants of the core curriculum."

a school requires G. S. of pupils in some courses (e. g., "technical," "commercial," "general") and leaves it optional for the pupils in other courses (e. g., "technical," "general," "commercial"). In some schools that spread "general science" over two or more grades below the ninth, the work is optional in the ninth grade but required below. Where G. S. is an optional subject, nearly every high school subject appears somewhere as an alternative, although in any given school the choice is likely to be limited.

The Range of Alternatives to General Science

Alternative subjects that pupils may choose as against General Science	Number of schools that offer alternative options
Biology	8
Botany	1
Zoology	1
Physiology	1
Chemistry	1
Physics	1
Physiography or Phys. Geog.	2
Civics (or History)	18
History specified	1
Foreign Language	25
Latin specified	1
Mathematics	13
Art	16
Mechanical Drawing	1
Shop work	20
Manual Training specified	1
Domestic Science	20
Commercial Subjects	19

Three replies state that General Science is optional, but do not indicate what the alternative options are.

In order to discover, if possible, how strongly General Science, as an optional subject, appealed to the pupils, the following question (Number 3) was asked; but the replies are not satisfactory because some teachers misunderstood the question, and others failed to obtain the necessary facts for significant completion.

3a. How many pupils are enrolled in General Science this term? Boys.................; Girls.................

3b. How many pupils (if any) selected other alternatives? Boys.................; Girls.................

In the 47 schools (or school systems) that require General Science, there were enrolled (spring semester, 1924) 4,071 boys and 4,183 girls in science classes. Among the other schools, 1,672 boys elected science as against 895 boys who selected other options. In addition, 1,780 boys are reported as enrolled in G. S. classes in schools that offer the subject as an option,

with no indication as to the number of boys who selected alternative options.

Among these same schools, eighteen report a total of 1,691 girls enrolled in (optional) G. S. classes, as against 728 girls who selected other subjects; and in addition 19 schools report 1,278 girls enrolled in (optional) G. S. classes, without indicating the enrollment in alternative subjects.

Enrollments in General Science and in Alternative Options

Subjects	Totals	Boys	Girls
Gen. Sci., Required	8,254	4,071	4,183
Gen. Sci., Optional	6,421	3,452	2,969
Of these, in schools not reporting *alternative* enrollments	3,058	1,780	1,278
in schools reporting *alternative* enrollments	3,363	1,672	1,691
In alternative subjects	1,523	895	728

It is obviously unfair to interpret these figures at their face value. While it is true that the ratio of "required" to "optional" is almost the same for the enrollments as it is for the schools (56% required enrollment; 54.5% required schools); and while the ratio for the two sexes is substantially the same, it is difficult to believe that twice as many pupils chose science as elected all the other options combined, especially when we consider the wide range of alternative subjects. It is more likely that school records generally do not permit the ready segregation of data in the form required for the answer of this question.

4. How many periods (of .... min.) per week are devoted to General Science?

	2	3	4	5	6	7	8

This question was asked on the assumption that "General Science" would be interpreted by those who were to make the replies as a single high school or junior high school unit falling in a particular year or grade; and that it could therefore be answered very simply by inserting the number of minutes in the first space (between *of* and *min.*) and by checking in the space corresponding to the *number of periods*. Because, apparently, the subject is distributed over several grades, a number of teachers took the block of squares with the figures to call for location of various number of periods *by grades*. After considerable study of the replies, however, it was possible to

collate consistent data for 78 schools. The results are given in the following table.

We have here a wide range both in the length of period (from 30 minutes to 81 minutes, with two modes, one at 40 minutes and one at 45 minutes) and in the number of periods per week (from 2 periods to 10, with 5 preponderating—42 cases). Apparently "General Science" in the lower grades is taught only two or three times a week, in most cases, and considered as a "minor" subject. Where the subject takes rank with the other full-time subjects, there is a tendency to allow additional periods for laboratory work.

Amount of Time Given to General Science. [3]

Minutes per Period	Periods per Week: 2	2–	3	4	5	6	7	7–	8	9	10
30	1										1
40	2	1	1		9	1	5	1	1		21
42			1		1						2
45			1	3	16	1	4	1		2	28
50				1	7		2				10
52				1							1
55		1	1		2		1				5
60	1				5		1		1		8
70					1						1
81					1						1
	4	2	4	5	42	2	13	2	2	2	78

B. On The Factors Involved In The Choice Of Material

The general content of the G. S. course can hardly be standardized in the sense of making a single schedule of topics that would be equally satisfactory for all kinds of schools or for all kinds of communities. It ought to be possible to present a wide range of materials that would effectively teach the essential principles, methods or ideals that we purpose to make our pupils take with them from the study of the subject; significant facts are to be found at hand everywhere. The questions regarding the influences that determine choice of topics were intended in good faith to bring out the information, without prejudice; nevertheless several teachers considered one or another of the questions "loaded," and either avoided answering or apparently answered with a feeling of apology. Seven questions in this

[3]In one group of schools (California) the amount of time as well as the incidence of the G. S. course is made to depend upon the intelligence classification of the pupils:

Normal or better, in ninth grade; two semesters of 7 forty-min. periods.

Slow normal or less, in 8th and 9th, 3 semesters of 5 forty-min. periods. In both groups, two periods per week are laboratory periods, *at least*. A minimum of fifty laboratory exercises is required of the slower pupils; from 75 to 100 of the brighter pupils. It is interesting to contrast with these plans, which *specify* a limitation of laboratory groups to 20 pupils and of recitation groups to 30 pupils, procedure in other parts of the country which virtually preclude laboratory experience and compel mass instruction of an almost purely verbal sort.

group deal with the selection of topics. The questions are stated in their entirety, and the answers summarized in the following table.

1 How far is the choice of subject matter in the teaching of Gen. Sci. in your school determined by a syllabus?

2 How far does a prospective examination influence selection of topics?

3 How far does the choice of topics depend upon the contents of the textbook used?

4 How far is the choice of topics influenced by local conditions?

5 To what extent is the choice of topics influenced by matters of current or temporal interest?

6 To what extent is the selection of topics determined by the teacher's own interest?

7 To what extent is the selection of topics determined by the interest of the pupils?

Under the first three questions space was provided for checking four degrees of control: Entirely; Much; Little; Not at all. Under the last four questions, the rubric "Entirely" was omitted. However, no reply conceded to any one of the three controls *entire* determination in choice of topics, so that all replies can be presented under three degrees:

Extent to Which Various Considerations Influence Choice of Topics in General Science.

	Much	Little	Not at all	Total replies[4]
Syllabus	24	13	45	82
Examination	13	10	57	80
Textbook	38	30	10	78
Local conditions	22	36	5	63
Current interest	32	43	8	83
Teacher's interest	19	56	14	89
Pupil's interest	52	22	1	75

The most striking features of the summary seem to be the following:

1. Seventy-one per cent of the schools seem to be uninfluenced by a prospective examination in selecting material of instruction in science. This leaves the teachers considerable freedom, in which the most prominent external restraint seems to be a "syllabus" which is more or less influential in some 45% of the schools. However, in a large proportion of cases the syllabus itself is the creation of the teachers, so that the restraint here is probably not serious.

2. That the textbook plays a prominent role in determining the content of instruction appears from the fact that only 13% of the schools (10 out of 78) claim to disregard the textbook entirely in determining what they are to teach.[5]

[4]The last column in the above table (Total replies) is of no significance, except to show the extent to which certain questions were not answered at all; and it may serve as a basis for converting the other figures into percentages.

[5]A state supervisor writes, "We feel very keenly that the course of study should be made to fit the needs of the students and as a consequence, . . we are using a great variety of textbooks in the state."

3. Nearly sixteen percent report that the "teacher's interest" plays no part whatever in determining the content of the instruction. There is reason to believe that in many cases teachers read into this question a certain unintended implication, namely, that the influence of the teacher's interest is more or less of an intrusion. For example, certain textbooks are criticized because they show too much the influence of the respective authors' specialties; or a warning that the inquirer's own interest be not allowed to weigh too heavily in evaluating materials in a textbook. The intention, however, in asking this question, was to discover in good faith both the opinions and the practises of teachers in this respect. The writers believe that both in a composite subject like General Science and in a more narrowly defined subject like Botany or History, the teacher's interest may legitimately determine a considerable portion of the content of instruction. In too many cases the one gleam of enthusiasm in a whole term's work comes when there is a close approach to a stray bit of information, or method, or personality in which the teacher is genuinely interested; and this occasional burst of enthusiasm may well outweigh in educational value several ponderous but perfunctory lessons. Perhaps less than sixteen percent "not at all" may be considered gratifying at this point, as against over 21% "much" and 63% "little."

4. That there is probably an increasing tendency to take into consideration current affairs, local conditions and the interests of the pupils in the selection of material of instruction, appears from the small number of schools that report disregarding these factors entirely. In the absence of definite information as to how the interests of the pupils are ascertained, or as to just how local and current matters are utilized, one might be tempted to suspect that the high scoring in these questions represent little more than pious wish. Especially may the results be questioned in view of the high influence ascribed to the textbook. It is probable that at least in many cases "current" or "local" interests are indeed exploited, but in terms of what the textbook has to offer on a given topic. On the other hand, we shall see that there is a very close connection between the proportion of schools that attach much weight to the pupils' interests, and the proportion that offer opportunity for individual laboratory work (C, 1).

In many individual cases an interpretation of the returns is difficult. For example, from one town we are informed that a

syllabus prepared by a committee of teachers controls the selection of material (and it must be said that it is a very good syllabus); that none of the other factors are considered at all, except the teacher's interest, which is credited with the *entire* responsibility for the choice of subject matter; whereas the pupils' interests are ignored—because the "whole field is covered." Presumably, therefore, the teachers' interests are sufficiently universal to include the whole field, and they coincide sufficiently with the syllabus on the one hand and the pupils' interests on the other to meet all reasonable requirements!

8 To what extent is Gen. Sci. as taught in your school correlated with other subjects?

Space was provided for checking under "Much," "Little" and "No" for ten different subjects, and blank spaces for two additional subjects. There was also included a request for any material illustrating methods of correlation; one reply stated that such material was enclosed, but it had not been included, and a request to the teacher for this material has not been answered. In a few cases some indication was given by comments, which are reproduced below.

Nineteen replies claimed no correlation whatever, although not without qualification[6]. Sixty-one schools reported as practising correlation between General Science and from one to eight other subjects, to a greater or less extent.

Number of schools in which General Science is correlated with each of several subjects to the extent indicated

Subjects	Much	Little	Not at all	Total Much and Little
Mathematics	6	30	9	36
English, Oral	24	17	3	41
English, Written	17	22	2	39
Civics	24	22	6	46
History	9	18	14	27
Shop (Manual Training)	21	24	7	45
Art	6	18	19	24
Domestic Science	26	16	6	42
Commercial Subjects	3	5	22	11
Vocational Subjects	18	6	14	24
Botany	1			
Zoology	1			
Advanced Science	1			
Hygiene	1			
Physical Education	1			
Physical Geography	1			

[6]"We pay attention to English in written and oral reports." "Cannot help being an English teacher." "Not consciously." "Very little conscious or purposeful correlation." "Not much." "Very little." "This has not been thoroughly worked out." "I am afraid that I cannot answer by estimate. I have in mind numerous correlations but it would require much time and space to enumerate."

Geography	2
Agriculture	3
Vocational Guidance	1

Some of the comments or explanations regarding correlation may help to interpret the meaning of these replies, and all are given in full:

"We give our science papers to English teachers to correct for English; we have science talks by people before the whole school once a week; Radio Club; Chemistry Club." "Only general with these subjects, but is correlated with other sciences." "A 300 or 400 word paper on the school heating plant or something similar is written and corrected for Physics and then independently by the scholars' English teacher. *Results good.*" "City water supply" (under Civics).

Apparently teachers approve the principle of correlation, even though there is no clear agreement as to just what it means, as to what it is for, or as to how it works. Indeed, one may well doubt whether the question itself is a legitimate one to ask in this connection. It is obvious that the specialization of subject matter among teachers has led to a serious mental condition: too often what is learned consists of a mass of unrelated and unassimilated facts or generalizations that never become unified in any dynamic influence upon the life of the high school graduate. Not only are the subjects unrelated to each other, as presented by teachers intent upon their respective specialties, but certain of the more general objectives of the school fail of accomplishment because they are left to specialists instead of being treated by all the teachers. This is illustrated by the fact that two thirds of the schools consider the objectives of "English" and of "Civics" sufficiently general to demand some attention from the Science teachers. Even if we consider these reports as expressing no more than wishes and opinions as to what is desirable and feasible, they may be significant. They point at least to (1) the feeling among teachers that *there is some need for more effective integration of the pupil's intellectual experiences*, and to (2) their belief that *General Science touches closely upon many phases of life and thought.*

Just what correlation means to most of us can hardly be extracted from the replies. It is probably in most cases a *verbal* linking of facts and principles discussed under "General Science" with applications and illustrations found in other subjects of the curriculum. In the case of mathematics it may mean merely the use of a few or many quantitative problems arising out of the science material. In the case of history it may mean both the historical development of important scientific ideas and an indication of the effects of human knowledge upon institutions

and ways of living. In the case of manual and domestic arts, it probably means chiefly practical applications of principles with occasional illustrations of others. But would the English teacher's occasional use of a reading excerpt from an historical or a scientific writer be considered a case of correlating English with history or science? When it comes to the commercial subjects the matter is still less clear; and with the additional subjects listed but once or a very few times one is often puzzled. For example, what does a teacher mean when he says that he correlates General Science of the 9th grade with "Advanced Sciences"—which, if taken by the same pupils, are studied two or three years later? Or what is the meaning of "Botany" and "Zoology" on the list? Probably in these cases also there is a verbal linkage with something that may be clear enough in the mind of the teacher, but hardly more than a vague repetition in that of the pupil. Nevertheless, there can be no doubt that there is in these replies a genuine feeling as to what ought to be done; methods and principles of procedure are still to be worked out. Indeed, it is conceivable that what is needed is chiefly an equipment and a point of view on the part of the teacher, rather than a precisely formulated technique of procedure.

9a Assuming that scientific method and ideals are to be a conscious part of teaching objective, should they be made an explicit part of the teaching process; or do you expect to emerge incidentally from the materials of instruction; or from the methods followed?

Eighty seven replies were received to this question, distributed as follows:

Explicit	32
Incidental	24
Method	31

This reply can best be considered in connection with the returns to *9b*, which in effect brings out some of the objectives of General Science teaching.

9b. Should General Science confine itself to imparting knowledge about scientifically determined facts and principles; or do you consider it essential that General Science attempt to inculcate so-called scientific methods of thinking and working, or scientific ideals (e. g., Objectivity, Accuracy, Suspension of judgment, Reliance upon verifiable facts, etc.)?

The 86 replies to this question gave 14 for knowledge (only); and 72 for scientific *attitudes and ideals*. The great preponderance of votes in favor of a conscious purpose to inculcate scientific habits of mind is important when compared with the judg-

ments on method (9a). We might have supposed that some of those whose opinions are recorded as opposed to the explicit teaching of scientific ideals might consider such ideals a subordinate or negligable objective. That apparently is not the case, since only fourteen expressed themselves in favor of confining instruction to knowledge aims, whereas nearly twice as many (24) expect ideals to emerge incidentally, and more than twice as many (31) expect them to come from the methods of instruction, laboratory, etc.

That the two parts of *9b* are not mutually exclusive is of course obvious, and was mentioned by three or four of the teachers sending replies; yet several were confused by the form of the question, assuming apparently that the second part precluded knowledge aims entirely, and these called attention to the fact that we *can develop ideals and attitudes in science only on a substratum of knowledge.* It is interesting to note further that all comments indicating a strong feeling were in favor of emphasis upon scientific ideals and attitudes.[6] At the same time, it should be noted that in some cases (4) the teachers feel the limited possibilities in this direction—lack of laboratory work, immaturity of the pupils, bad mental habits from previous training being indicated. There is also some indication that the latter part of *9b* implies some sort of reconciliation with the doctrine of "general discipline," (which was of course not intended) for some of those who replied favorably.

A comment on the two parts of *9* that probably expresses the views of many of those who replied is the following: "Too much formality should be avoided in General Science. Scientific accuracy and completeness should not damage enthusiasm. In general, the methods of chemistry and physics are not best for General Science." The writer apparently has in mind the use of mathematics as sometimes overdone in the teaching of chemistry and physics. "I think the main purpose is to create enthusiasm for science, and a power of observation as to the scientific principles of everyday things. The experimental work should give much training in resourcefulness."

Most interesting to the writers is the result of this question as throwing some light on a certain defect in the questionnaire

"[6]The latter of course;" "Emphatically the latter;" "Decidedly;" "By all means." One teacher writes "No one seems to be doing what I believe we shall be doing ten or fifteen years from now, that is, giving concrete material of interest to the children and yet giving it in such a way that the great *generalizations of science* are made perfectly familiar . . . ." He explains further that he would not burden the pupil with generalizations to be remembered, but have him study the particulars so that the mind passes inductively to the generalizations. "The greatest job before general science teachers is to make General Science *general*."

method. One is tempted sometimes to suspect that any desired general opinion may be obtained from a given group of subjects, if only the questions are suitably framed to that end. In contrast to the present results, it is instructive to consider three earlier studies that sought the judgment of teachers as to the aims of General Science.[7] Watkins found that "training in scientific method" stood fourth in rank; Howe, that it stood a very poor third; and Miller (Illinois), Roecker (Wisconsin), and Worun (Michigan) had this aim mentioned among the miscellaneous minor aims. In the summary of four surveys (not counting his own) and including 353 replies, Watkins shows 85% emphasizing three major aims—"Understanding, appreciation and control;" "Fund of valuable information;" and "Preparation for later sciences."

Scientific attitudes and ideals were mentioned in all of the four studies summarized by Watkins; scientific attitudes and ideals are among the several miscellaneous aims stressed by fifteen per cent of the replies. It is interesting in this connection to recall the four aims of General Science presented by Assistant Superintendent Lake of Cleveland before the Chicago meeting of the Central Association of Science and Mathematics Teachers, December 1922.[8] Independence of thinking and acting; the habit of accuracy and exactitude; the habit of suspended judgment; the habit of perseverance and work. It is possible that the discrepancy between these earlier statements and aims and those received in reply to the present inquiry represent a general tendency to shift the emphasis rather than differentiated responses to suggestions within the various questionnaires. For the present, however, it is impossible to draw further inferences from the data at hand.

C. On Method

1. Have your pupils in general science opportunity for individual laboratory work?

The amount of laboratory work, as has already been intimated, is decidedly inadequate. Only seventy teachers answered this question directly (51 say that the pupils have opportunity for individual laboratory work, and 19 that they have not). It is safe to assume that the missing replies represent schools

[7] Watkins, R. K. The Technique and value of General Science Teaching, General Science Quarterly, 7:235-256, May, 1923.

[8] General Science Quarterly, 7:92-101, January, 1923, and School Science and Mathematics 23:268-277, March, 1923.

in which laboratory facilities are entirely lacking. When it comes to specifying the amount of laboratory work, thirteen of the teachers who claimed to have laboratories failed to answer. Two periods per week is the prevailing amount of time (18 out of 38 schools). One school reports ten periods a week of laboratory work without indicating the length of the periods; and one school reports five periods of eighty-one minutes each.

Number of Periods of Laboratory Work in General Science

							Not Reporting	Total Schools
Number of Periods	1	2	3	4	5	10		
Number of Schools	4	18	3	5	7	1	13	51

2 Are your pupils in Gen. Sci. required to carry out home projects?

Out of 78 schools (or school systems) replying, 52 or two thirds require home projects of some kind to be carried out, whereas 26 do not. Very few teachers submitted examples of such projects. A few representative examples are "How to save on gas bills," "Wiring door bells," "Building trap nest," "Developing and printing photographs," "Mosquito and fly campaigns," "Capturing and finding out life history of fruit fly."

3 Do your classes in Gen. Sci. have opportunity to visit plants and institutions during school hours?

Slightly more than 25% of the schools reporting (21 out of 78), claim to make no use whatever of visits. Nearly as many, however, (19) report visits during school hours as well as after school hours. The rest are evenly divided between using school time and after-school time.

(Continued in December.)

STUDENTS ARE YACHT BUILDERS AND STONE WORKERS.

Dominant local industries inevitably affect the studies in the schools of any community. San Diego, Calif., for example, is on a bay which is large enough to give safe anchorage to 300 battleships, and it is rare that the harbor is without a considerable number of them. Many of the people of the city look to the ocean for their livelihood or for their principal diversion. The courses of the school shops reflect that condition. Nothing else in those shops arouses so much interest as the building of boats and of models of racing craft. Yachting enthusiasts and expert boat builders encourage this study and cordially cooperate with the shop teachers.

Similarly, in Bedford, Ind., the center of a great quarrying district, stone drafting and stone working are strongly emphasized. The senior high school has a complete equipment for planing stone and for shaping and dressing it, and the vocational courses offered are of the most practical character. Numbers of the boys elect those courses, for they are not only of great interest in themselves but they lead to remunerative work after graduation.—School Life.

PROBLEM DEPARTMENT.

CONDUCTED BY C. N. MILLS,
Illinois State Normal University, Normal, Ill.

This department aims to provide problems of varying degrees of difficulty which will interest anyone engaged in the study of mathematics.

All readers are invited to propose problems and to solve problems here proposed. Drawings to illustrate the problems should be well done in India ink. Problems and solutions will be credited to their authors. Each solution or proposed problem, sent to the Editor, should have the author's name introducing the problem or solution *as on the following pages.*

The Editor of the department desires to serve its readers by making it interesting and helpful to them. Address suggestions and problems to C. N. Mills, Illinois State Normal University, Normal, Ill.

SOLUTION OF PROBLEMS.

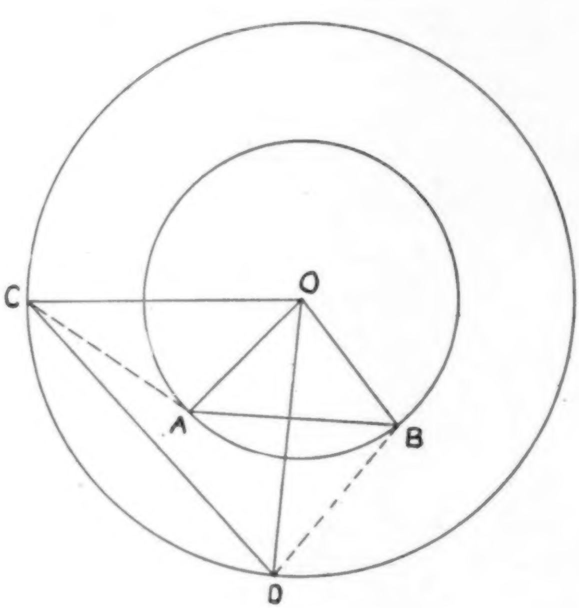
881. *Suggested by Problem 869.*

By the compasses only, find tbe fourth proportional to three given lines

I. *Solved by Michael Goldberg, Philadelphia, Pa.*

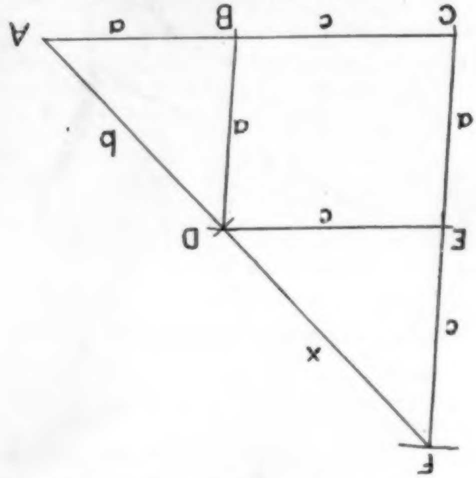
This construction is given in Adler's "Theorie der geometrischen Konstruktionen."

With center 0, draw circles of radii a and b. Draw chord $AB = c$ on circle of radius a. With any convenient length as a radius and with A and B as centers, draw arcs intersecting the other circle at C and D. Then triangle AOB is similar to triangle COD, and $CD = x$ such that $a:b = c:x$.



If c is larger than the diameter of the circle, divide it into n parts by method of Problem 862 and multiply the fourth proportional found by n.

II. *Solved by J. Murray Barbour, Ardmore, Pa.*

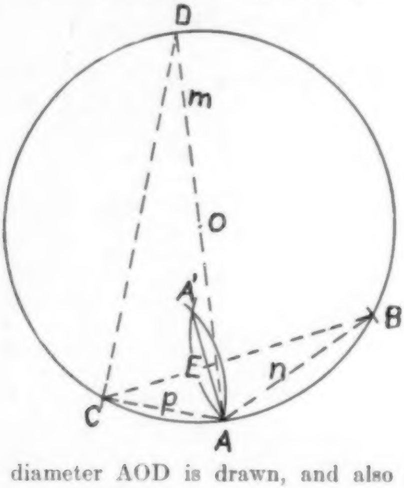


On a given straight line locate the points A, B, and C, so that AB $=a$, BC $=c$. With A and B as centers, and with radii b and a respectively, draw arcs intersecting AB at D. With C and D as centers, and radii a and c respectively, draw arcs intersecting at E, diagonally opposite to B. With E and C as centers, and with radii c and $(a+c)$ respectively, draw arcs intersecting at F. FD is the required fourth proportional.

Discussion. The above construction can be made only when $b<2a$. If $b>2a>c$, interchange b for c and construct as above. If $c>b>2a$, find a number k so that $2ka>b$, and use ka and kc instead of a and c in the above construction. Again, if $b>c>2a$, it will be easier to interchange b and c, using ka and kb.

III. *Solved by George Sergent, Guatemala, C. A.*

Draw a circle of radius m. From any point A on the circumference mark off the arcs AB and AC subtended by chords equal to n and p respectively. Determine A′, symmetrical to A with respect to BC. The distance AA′ is the required fourth proportional.



Proof. If the diameter AOD is drawn, and also AA′ intersecting

BC at E, the right triangles ACD and AEB are similar. Hence AD:AB = AC:AE, or $2m:n = p$:AE. This reduces to $m:n = p$:AA′.

See June, 1922, issue for other constructions.—Editor.

882. *Proposed by W. W. Horner, Redstone H. S., Republic, Pa.*

A 100-foot chain is suspended from the ends of a 50-foot horizontal beam. Find the distance from the center of the beam to the lowest part of the chain.

Solved by Norman Anning, University of Michigan.

Let us assume that the chain is uniform. It will hang in a catenary whose equation, when referred to suitably chosen axes, is $y = a \cosh (x/a)$. If s is the length of the arc measured from the vertex $(0, a)$ to any point (x, y) on the curve, it is known that $s = a \sinh (x/a)$. From the values of y and s, it follows that $y^2 - s^2 = a^2$. When $s = 50$ and $x = 25$, we have $2(25/a) = \sinh (25/a)$. Solving this equation by trial, we find that $a = 11.482$, then $y = 51.301$. The required distance $(y - a)$ is 39.82 feet.

Also solved by *Michael Goldberg, Philadelphia, Pa.; John Ankebeant, River Rouge, H. S., Michigan; J. Murray Barbour, Ardmore, Pa.;* and the *Proposer*. One incorrect solution was received.

883. *Proposed by J. Murray Barbour, Ardmore, Pa.*

(a) Six playing cards are laid down in a row in a certain order. If they are gathered and shuffled and laid down again, what is the chance that at least one of the cards appear in the same position as before. (b) When there are n cards, instead of 6, what is the limit of the chance as n approaches infinity?

Solved by the Proposer.

The chance can easily be computed when there are only a few cards. First find the number of favorable arrangements when the first card is in position; then, the additional (i. e., different) ones when the second card is in position. Proceed in like manner with the other cards.

No. Cards	*Favorable Arrangements*					*Totals*
5	24	18	14	11	9	76
4	6	4	3	2		15
3	2	1	1			4
2	1	0				1
1	1					1

These numbers (logically enough) form a subtraction series as shown above in which the first term of the nth row is $(n-1)!$

It will be seen from the column of totals that $S_n = n \cdot S_{n-1} + (-1)^{n-1}$.

$$\text{Chance}_n = \frac{N.S_{n-1} + (-1)^{n-1}}{n!} = \text{Chance}_{n-1} + \frac{(-1)^{n-1}}{n!}.$$

$$\therefore \text{Chance}_n = 1 - \tfrac{1}{2} + \tfrac{1}{6} - \tfrac{1}{24} + \tfrac{1}{120} \cdots\cdots + \frac{(-1)^{n-1}}{n!}.$$

(*a*) When there are 6 cards the chance is $\frac{455}{720}$ or $\frac{91}{144}$

(*b*) $e^x = 1 + x + \frac{x^2}{2!} + \frac{x^3}{3!} + \frac{x^4}{4!} \cdots\cdots$

Write -1 for x.

$e^{-1} = 1 - 1 + \frac{1}{2} - \frac{1}{6} + \frac{1}{24} \cdots\cdots$.

$1 - e^{-1} = 1 - \frac{1}{2} + \frac{1}{6} - \frac{1}{24} \cdots\cdots$.

Hence, limit of chance$_n = 1 - e^{-1}$.
$(n \doteq \infty)$

One incorrect solution was received.

884. *Proposed by J. K. Elwood, Supt. of Schools, Philipsburg, Mont.*

By algebraic devices (not by the Factor Theorem, nor by approximations)

solve $$x^3 - x^2 - 2x - 12 = 0.$$

I. *Solved by J. Murray Barbour, Ardmore, Pa.*

$$x^3 - x^2 - 2x - 12 = 0.$$
$$x^3 = x^2 + 2x + 12.$$

If a perfect cube be added to the left-hand member it can be factored.

This number must be so chosen that when added to the right-hand member it can be factored also. From the second condition it is clear that the number must be negative. -27 fulfills both conditions.

$$x^3-27=x^2+2x-15.$$
$$(x-3)\ (x^2+3x+9)=(x-3)\ (x+5).$$
$$(x-3)(x^2+2x+4)=0.$$
$$x=3 \text{ or } -1\ \pm\sqrt{-3}.$$

II. *Solved by Tillie Dantowitz, K. H. S., Philadelphia, Pa.*

Subtracting and adding $6x$ to the given expression we get

$$x^3-x^2-6x+4x-12=0.$$
$$(x-3)\ (x^2+2x)+4\ (x-3)=0.$$
$$(x-3)\ (x^2+2x+4)=0.$$

Hence $x=3$, and $(-1\pm\sqrt{-3})$.

Three solutions were received, in which use is made of Cardan's formula for the general cubic equation, one solution by *J. K. Ellwood, Philipsburg, Mont.*; one solution by *Michael Goldberg, Philadelphia, Pa.*; and one solution by *George Sergent, Guatemala, C. A.* One incomplete solution was received from *Judd Lippincott, Union College, College View, Neb.* One incorrect solution was received.

885. *For High School Pupils. Proposed by Tillie Dantowitz, pupil at the Kensington H. S., Philadelphia, Pa.*

Given any three angles, A, B, and C, and the relations:

$$A+x+y=90^\circ \qquad B+y+z=90^\circ \qquad C+z+x=90^\circ.$$

Find, by geometric constructions, the angles x, y, and z.

Solved by the Proposer.

Construct three right angles, DEF, HIJ, and LMO. Make DEG $=\angle$A, HIK $=\angle$B, and LMN $=\angle$C. Then GEF $=(x+y)$, KIJ $=(y+z)$, and NMO $=(x+z)$.

Draw EP making GEP $=(y+z)$, then PEF $=(x-z)$. Draw EQ making FEQ $=(x+z)$, then PEQ $=2x$. Bisecting angle PEQ gives angle x.

Draw MS making NMS $=x$, then SMO $=z$.

Draw IT making KIT $=z$, then TIJ $=y$.

PROBLEMS FOR SOLUTION

896. *Proposed by R. T. McGregor, Elk Grove, Calif.*

The centers of the four circles circumscribed about the triangles formed by four straight lines are concyclic.

897. *Proposed by F. A. Cadwell, St. Paul, Minn.*

Using the compasses alone, divide a given line segment into two parts, one part being equal to the side of a regular decagon inscribed in a circle whose radius is equal to the other part.

898. *Proposed by Norman Anning, University of Michigan.*

An equilateral triangle ABC is inscribed in a circle. D is any point on the minor arc AB. Show that the area of ACBD is equal to the area of the equilateral triangle which has CD for a side.

899. *Proposed by Tille Dantowitz, K. H. S., Philadelphia, Pa.*

$$bx^2+lx+c=0.$$
$$cy^2+my+a=0.$$
$$az^2+nz+b=0.$$

Eliminate x, y, and z, and get the equation

$$al^2+bm^2+cn^2+lmn=4abc.$$

900. *For High School Pupils. Proposed by C. E. Githens, Wheeling, W. Va.*

A and B are at different points on a straight road. A travels toward B and reaches B's original position eleven minutes after B had left. B travels toward A and reaches A's original position fifteen minutes after A had left. Each then starts back and meet half way at 4 P. M. When did each start?

In providing homes for teachers, Texas claims first place; a recent report to the United States Bureau of Education shows a total of 635 for that State. Nearly 600 of these homes are in rural districts.

THE FIRST YEARBOOK OF THE NATIONAL COUNCIL OF MATHEMATICS TEACHERS

AN ANNOUNCEMENT

BY PROFESSOR RALEIGH SCHORLING

President of the National Committee of Mathematics Teachers.

At the last annual meeting at Cincinnati the Council voted to publish a yearbook containing helpful naterials for teachers of Mathematics. This yearbook is to be presented as the program for the 1926 meeting. In accordance with this action the president of the National Council appointed the following committee: Mr. Charles M. Austin, Chairman, Dean John H. Minnick, Mr. William Betz, Professor Walter E. Eells, and Professor Frank Touton.

The next meeting will be held at Washington, D. C., on Saturday, February 27th. It is hoped at this time to present a strong program and an excellent yearbook.

The details concerning content, publication and distribution will need to be approved by the Executive Committee of the Council. It is proposed that we build a yearbook around the general theme, "The Progress of the Past Twenty-five Years in the Teaching of Mathematics in Elementary and Secondary Schools." Credit for this suggestion is due Mr. William Betz.

Tentative plans for the yearbook include the following:

1.—The Presidential Address by Professor E. H. Moore. This is a reprint of the address which Professor E. H. Moore delivered before the American Mathematics Society and which has so profoundly stimulated progressive thinking on the teaching of High School Mathematics.

2.—Twenty-five Years of Progress in the Schools of England, a summary by Professor T. Percy Nunn.

3.—Recent Tendencies in the Schools of Germany by Professor J. W. Young.

4.—A summary consisting of (1), the story of our syllabuses. (2), the work of the International Commission. (3), the story of the National Committee and its work. (4), the attempts at curriculum construction, etc. It is suggested that this summary be undertaken by one of the following: Professor J. W. A. Young, Professor D. E. Smith, Professor G. W. Myers, or Mr. William Betz.

5.—Measuring Instruments of Long Ago, a reprint of Mr. Stark's article.

6.—A summary of the present testing movement with a *critique* of tests; it is hoped that Professor Clifford B. Upton will undertake this as he needs only to abbreviate and supplement his material of chapter 13 in the Reorganization of Mathematics in Secondary Education.

7.—The Making of a Modern Survey by Professor Raleigh Schorling.

8.—A Statement of the Modern Point of View as to the Psychology of Drill by Raleigh Schorling.

9.—A Biography of Books Published since 1920 by Professor J. Robert Overman.

10.—The Teaching of Trigonometry in the Junior High Schools by Mr. Richard McDaid.

11.—By Products from the movement in education as concerns the teaching of Mathematics. It is hoped that one of the following may undertake this unit: Professor E. L. Thorndyke, Dr. John R. Clark, or Dr. Clifford B. Woody.

12.—The Teaching of the Metric System in Relation to the Teaching of Decimal Fractions. Miss Selma Lindell.

13.—What are we able to do in Mathematics by way of diagnosis and remedial treatment? Leroy Schnell.

No one man or a publication committee can make a yearbook. We will need the experience of many alert workers in our field. You are hereby urged (1), To criticize the preceding outline. (2), To make suggestions as to the other units to be included. (3), To choose some unit and develop it, and (4), To send your section to some member of the editorial committee or to the writer not later than November 15th.

The preceding topics will also be used as the main part of the program at the Mathematical Section at the Thanksgiving meeting of the Central Association. R. S.

AMERICAN EDUCATION WEEK, Nov. 16 to 22, 1925.

The following program for the observance of AMERICAN EDUCATION WEEK this year has been agreed upon by the Bureau of Education, the National Education Association and the American Legion, under whose joint auspices AMERICAN EDUCATION WEEK is promoted annually. The week will start on Monday, November 16, and end on Sunday, November 22.

Monday, November 16, Constitution Day

"The Constitution is the bulwark of democracy and opportunity."

1. Unity, justice, tranquility, defense, welfare and liberty.
2. Our Constitution guarantees these rights.
3. Our Constitution is the expression of the will of the people.
4. One Constitution, one Union, one Flag, one History.

Slogans—"Ballots, not bullets," "Know the Constitution," "Visit your schools today."

Tuesday, November 17, Patriotism Day

"The Flag of the United States of America is the symbol of the ideals and institutions of our Republic."

1. Our Flag insures the sanctity of life and the security of property.
2. Quicken the sense of public duty.
3. Voting is the primary duty of the patriot.
4. Our national honor must be preserved from unjust attack.

Slogans—"America first," "Vote at all elections," "Visit your schools today."

Wednesday, November 18, School and Teacher Day

"It is not too much to say that the need of civilization is the need of teachers."—Calvin Coolidge.

1. The teacher is a nation builder.
2. The school is the foundation of democracy.
3. Provide for the needs of your schools.
4. Trained teachers require adequate compensation.
5. The teaching of patriotism is the duty of all public servants.

Slogans—"The better the teacher the better the school," "Visit your schools today."

Thursday, November, 19, Conservation and Thrift Day.

"The forests of America, however slighted by man, must have been a great delight to God."—John Muir.

1. Conserve our national resources.
2. Prevent forest fires.
3. Industry and thrift spell prosperity

4. Saving insures happiness.

Slogans—"Plant a tree," "Work and save," "Visit your schools today."

FRIDAY, NOVEMBER 20, KNOW YOUR SCHOOL DAY.

"Progressive civilization depends upon progressive education."

1. Schools must progress with the times.
2. Preparation for modern day life demands a broader course of study.
3. The school must be kept abreast of science and invention.
4. A little invested in education saves much expended on crime, poverty and disease.

Slogans—"Good schools for all communities," "Make your schools livable," "Visit your schools today."

SATURDAY, NOVEMBER 21, COMMUNITY AND HEALTH DAY.

"Physical education means health and strength."

1. The school is a community center.
2. Equality of opportunity for every American boy and girl.
3. Public library service for every community.
4. Proper food and rest for children.
5. A health officer for every community.
6. Adequate parks for city, state and nation.

Slogans—"A square deal for the country boy and girl," "A sound mind in a sound body," "Visit your neighbor today."

SUNDAY, NOVEMBER 22, FOR GOD AND COUNTRY DAY.

"Religion, morality, and education are necessary for good government."

1. Education in the home.
2. Education in the school.
3. Education in the church

Slogans—"A Godly nation cannot fail," "Visit your Church today."

NORTHERN CALIFORNIA CONFERENCE ON SCIENCE TEACHING.

Dr. Edna W. Bailey and Mr. Clyde M. Westcott, Pacific Coast members of the Committee on the Place of Science in Education of the A. A. A. S., requested the School of Education of the University of California to conduct two conferences on the problems confronting that Committee. One was held in Berkeley, under the auspices of the Summer Session, on July 17 and 18; the other will be held at the Southern Branch in Los Angeles on August 3 and 4.

It was planned to make this a small working conference, composed of those who have certain responsibilities with regard to the teaching of science in this state. The plan outlined by Dr. Otis W. Caldwell, Chairman of the Committee, was used as a basis for the preparation of the program, which follows.

FRIDAY, JULY 17.

9:30 a. m.

General Meeting and Organization, Chairman: Prof. George W. Hunter, Knox College, Galesburg, Illinois. Discussion:

Present situation in science teaching in California. What subjects are taught, where, when, in what year, in what sequence; the training of teachers and the load carried by teachers. Leader: Miss Elizabeth Bishop.

2:00 p. m.

THREE SECTION DISCUSSIONS.

The Science Laboratory; Planning and Equipping. Standard lists. Costs. Leader: Mr. Clyde M. Westcott, Head of Science Department, Hollywood High School.

The Synthetic View of Science in Relation to Organization of Courses in High School and College. Leader: Dr. Richard Holman, Asst. Prof. of Botany, University of California.

Science and Health: What are the Scientific Fundamentals Essential for Health Education? Leaders: Dr. J. N. Force, Prof. of Hygiene, University of California. Dr. Agnes Fay Morgan, Prof. of Household Science, University of California, Dr. Richard Bolt, Asst. Prof. of Hygiene, University of California.

SATURDAY, JULY 18

9:30 a. m.

Discussion: Present day problems. Relation of Science Teaching to Religious Education. Leader: Dr. Edna W. Bailey, Supervisor of the Teaching of Science, University High School, Oakland. How shall we treat the Evolution Theory in Teaching Elementary Biology? Leader: Miss Mabel B. Peirson, Head of the Department of Biological Sciences, Pasadena High School.

Luncheon, 12:30 p. m.

Science for the Millions. Speaker: Dr. William E. Ritter, President Science Service, Inc. Science in the Secondary Schools. Speaker: Dr. Leonard V. Koos, Prof. of Secondary Institutions, University of Minnesota.

Afternoon

VISIT TO LABORATORIES AT UNIVERSITY HIGH SCHOOL.

The date of the conference happened to coincide with the climax of the Scopes trial, and in consequence it received much unexpected and undesired publicity. The conference was well attended and participation in the discussion was general. The following recommendations were unanimously adopted.

The science teachers of northern California assembled in this conference note with interest the following tendencies and needs in the field of Science:

The four dominant sciences in the high schools of California are General Science, Biology, Chemistry, and Physics. Botany, Zoology, and Physiography have been disappearing and there has been a large increase in General Science and Biology.

ORDER OF SCIENCE COURSES.

There is considerable confusion throughout the state in regard to the desirable sequence of science courses. After considering the tendency in the state and throughout the country, the conference recommends that General Science be offered by the Junior High Schools in the seventh grade and in at least one other year. In the four year high schools, General Science is recommended for the ninth grade. Biology should be given in the tenth grade. It is recommended by the conference that a Life Science be required of all students in the tenth grade. Chemistry and Physics should be offered in the 11th and 12th grades. While there seems to be a greater tendency for students to take Chemistry in the eleventh and Physics in the twelfth, there is not sufficient reason to limit choice in the order of these two sciences.

There is great need for a definition by the College Entrance Board of the subject of Physiology as an advanced science for the third or fourth year of High School.

It is recommended that the University offer two elementary courses in each science, one for those who have had High School work in that subject, the other for beginners.

Many teachers are required to teach science without adequate preparation and many teachers prepared in science are required to teach other subjects. From five to fifty per cent of the teachers in the different schools of California teach some science, and forty-seven per cent of the science trained teachers are teaching other subjects in the high school curriculum. The conference urges increased attention on the part of high school principals to the assignment of teachers to subjects in which they are properly prepared.

General Science and Biology constitute a large part of the science in the high schools of the state. Teachers of these subjects have not had proper training. There is distinct need of help from the University in the form of training in subject matter used in the two courses mentioned. The conference requests the University to provide adequate preparation, such preparation to include courses from the following fields of science: Chemistry, Physics, Botany, Zoology, Biology, Physiology, Bacteriology, Public Health and Nutrition. (There was a general feeling that Earth Science should also be included.)

In order that science teachers might be better able to realize the possibilities of Science in training young people to meet problems of modern life, it is recommended that an extensive and thorough experimental study be made of the science training needed by the individual living in modern society, the selection and organization of subject matter, and the choice of methods to be used in order to realize these desired ends.

It is recommended that the Commissioner of Secondary Education of California provide a clearing house for laboratory plans, specifications for laboratory furniture, equipment, and standard lists of supplies for each of the courses now commonly given in the secondary schools of the state. Also that copies of such material be prepared and made available to all courses now commonly given in the secondary schools of the teachers of science who desire them.

Free instruction in taxidermy is given to Boy Scouts by the American Museum of Natural History in New York City. The instruction is individual, and the boys are encouraged to thorough work by the offer of a taxidermy badge.

PHENOMENAL GROWTH OF INSTRUCTION IN SWIMMING.

A striking adventure in American pedagogy is the growth of instruction in swimming and watermanship. High-school buildings and playgrounds contain swimming facilities. Many colleges include swimming as a prerequisite for a degree. In military posts and at summer civilian training camps instruction in swimming is given as a matter of course. The American Red Cross has been the most significant factor in promoting water safety. In Chicago, New York, Boston, and Springfield are institutions that produce swimming directors.—*School Life.*

Quarter-Centennial Meeting of the

Central Association of Science and Mathematics Teachers

November 26, 27, 28, 1925

At the University of Chicago

Fifty-Seventh Street and University Avenue, Chicago, Ill.

Instructions on Railroad Rates. Members in Colorado, Idaho, Illinois, Iowa, Kansas, Minnesota, Missouri, Montana, Nebraska, Northern Michigan, North Dakota, South Dakota, Utah, Wisconsin and Wyoming will buy round trip tickets to the International Live Stock Exposition at the rate of one and one-third fare. Minimum fare $2.00. Tickets are on sale 12:01 a. m., November 27, except for points west of the Missouri River, where they are on sale twenty-four hours earlier.

Members living in the territory of the Central Passenger Association will buy a full fare ticket to the meeting of the National Committee on Boys and Girls Club work which meets in connection with the International Live Stock Exposition. Secure from the local ticket agent a certificate with this ticket. Turn this certificate in to the registration desk at Headquarters of the Central Association, Reynolds Club for validation. The rate granted is a one and a half fare rate.

Headquarters Hotel, The Del Prado, Fifty-ninth St. and Dorchester Ave. Other nearby hotels are the Gladstone, Sixty-second St. and Kenwood Ave., Windermere, 1642 East Fifty-sixth St., Hyde Park Hotel, 1151 E. 51st St., Hayes Hotel, 6345 University Ave.

Low rates are available down town at the Y. M. C. A. Hotel, 822 S. Wabash Ave., and at the Y. W. C. A.

To reach the University take Illinois Central express trains at Michigan Ave. and Randolph St. or Van Buren St. to Fifty-seventh St., Jackson Park express trains on the Elevated to University Avenue and Sixty-third Street, or take No. 7 Bus on Michigan Avenue which passes the University on 60th Street.

Registration Headquarters, The Reynolds Club, S. W. Corner 57th St. and University Avenue.

Executive Committee Meeting, Thursday, Nov. 26, 7:30 p. m. at the Del Prado Hotel. Present officers and past presidents are expected to attend.

Friday, Nov. 27, General Session, 10:00 a. m. Leon Mandel Assembly Hall, 57th St. and University Ave.

Address of Welcome—President Max Mason of the University of Chicago.

Light Waves and Light Quanta—Dr. A. H. Compton, University of Chicago.

Members of the Association are invited to take seats in the gallery and remain to the University Chapel Service 12-12:30.

The University Commons at the end of the hallway from Mandel Hall is open to all members for meals, cafeteria plan.

Exhibits are in the Hallway of Reynolds Club, South-west corner 57th St. and University Ave.

Friday, 4 p. m. A personally conducted tour of the University buildings, also inspection of the several Science buildings, under guidance of some member of each department, for those who prefer to see one Science Department in detail rather than the University in General.

Friday, 5:30 p. m. Reception in honor of Past Presidents, Reynolds Club, 57th St. and University Ave.

Friday, 6:30 p. m. Dinner, Past Presidents as guests. University Commons. The after dinner speakers will be Dr. Gerald B. Smith of the University of Chicago. Subject: Are Science and Religion Incompatible.

Friday, 8:30 p. m. An illustrated lecture. The Little Theatre, Reynolds Club. Rollo Chamberlain, Dept. of Geology—Mountain Climbing in the Rockies.

Section Meetings

Friday p. m., November 27

BIOLOGY SECTIONS. Fred W. Werner Chairman, Room 14, Zoology Bldg. Survey of Recent Progress made in Zoological Research. Dr. C. E. Thoraldson, Northwestern University.

Survey of Recent Progress made in Physiological Research. Dr. A. J. Carlson, Chairman, Dept. of Physiology, University of Chicago.

CHEMISTRY SECTION. Margery Stewart, Chairman, Kent Theatre, Kent Chemical Laboratory.

Application of Absorption Spectra to the Solution of Problems of Inorganic Chemistry. Dr. H. I. Schlessinger, University of Chicago.

Artificial Silk, Miss Nierick of Sears, Roebuck & Co.

Some New Processes of Baking, Dr. H. E. Barnard, American Institute of Baking.

Methods in the Teaching of Chemistry. Chas. J. Pieper, University of Chicago, The School of Education.

GENERAL SCIENCE. H. P. Harley, Chairman, Room 13, Botany Building.

Planning the General Science Recitation.
Dr. Paul I. Pierson, Chicago Normal College.

New Books and Articles in the Field.
Hanor A. Webb, George Peabody College for Teachers.
Francis D. Curtis, University High School, University of Michigan.

New Apparatus for General Science.
Ira A. Davis, University High School, University of Wisconsin.
Hanor A. Webb, Peabody College for Teachers.

New Curriculum Units.
E. S. Osbourn, John Burroughs High School, St. Louis.
W. F. Roecher, Boys' Technical High School, Milwaukee.
Miss Anna P. Keller, Lake View High School, Chicago.
E. B. Collette, Lake View High School, Chicago.

Research in the General Science Field.
Earl R. Glenn, Lincoln School of Teachers College, New York City.
S. Ralph Powers, Teachers' College, New York City.

GEOGRAPHY SECTION. Katherine Ulrich, Chairman, Room 2, Rosenwald Hall.

Appointment of Nominating Committee. 10 minutes will be taken for discussion following each paper.

Schemes for Presenting Regional Geography. D. S. Whittlesey, Department of Geography, University of Chicago, 30 minutes.

Students Habits of Study and Appreciation of Geography. Leavelva M. Bradbury, State Normal School, Oshkosh, Wisconsin, 15 minutes.

The Dairy Industry of Wisconsin as a Geographic Adjustment. Glen T. Trewartha, Department of Geography, University of Wisconsin, 30 minutes.

Interests of Geography Teachers in the Area of the Central Association. L. H. Halverson, Joliet, Ill., High School.

MATHEMATICS SECTION. Raleigh Schorling, Chairman.

The Little Theater, Third Floor of Reynolds Club.

Individual Instruction in a Course in Demonstrative Geometry.
Miss Mary Potter, Supervisor, Racine, Wisconsin.

Wisconsin High School Plan of Trying to Educate to Capacity in Mathematics.
Professor Walter W. Hart, University of Wisconsin.

Individualized Instruction in the First Year of Algebra.
Miss Selma A. Lindell, University High School, University of Michigan.

What Can Be Done as Diagnosis and Remedial Treatment.
Leroy A. Schnell, Ann Arbor, Mich.

General Discussion of the topic, Individual Instruction.
Professor Ernest Breslich, The Univerity of Chicago High School.
Mr. Joseph Gonelley, in charge of Junior High Schools, Chicago.
Mr. Edwin W. Schreiber, Proviso Township High School, Maywood, Ill.

PHYSICS SECTION. Ryerson Physics Laboratory. Elmer E. Burns, Chairman.

Recent Developments in Optics, Dr. Henry Gordon Gale, The University of Chicago.

Changing Methods in Physics Teaching, Mr. Frank E. Goodell, West High School, Des Moines, Iowa.

A New Type of Physics Laboratory and Class Room, Mr. Earl E. Glenn, Teachers College, Columbia University.

A new type of Physics test. N. Henry Black, Howard University.

Saturday, 9:00 a. m. Business Section, Room 13, Botany Building.

Saturday, 10:00 a. m. All-Science Section Meeting. Kent Theatre, Kent Chemical Laboratory.

Recent Work on the Ether-Drift, Dr. Dayton C. Miller, Case School of Applied Science, Cleveland, Ohio. President of the American Physical Society, 40 minutes.

Survey of Recent Progress in Botanical Research. Dr. Merle Coulter, University of Chicago, 30 minutes.

Demonstrations of Electric Collisions. Dr. W. D. Hockins, University of Chicago, 30 minutes.

The General Science Course. Chas. H. Lake, First Assistant Superintendent of Schools, Cleveland, Ohio, 30 minutes.

Saturday, 12:30 p. m. Meeting of the Executive Committee, private dining room, Quadrangle Club. S. E. corner University Ave. & 57th St.

Saturday, 1:30 p. m. A conducted tour of the International Live Stock Show Stock Yards.

Write Dr. Elliot R. Downing, President, University of Chicago or Ada L. Weckel, Secretary, Oak Park, (Ill.) High School for further particulars.

Printed programs will be mailed to members about Nov. 1.

THRIFT WEEK.

The teaching of thrift, always a subject of great interest to progressive educators, will once again be made easy according to recent statements received from the office of Mr. Adolph Lewisohn, Chairman of the National Thrift Committee. Many teachers took advantage of the cooperation along these lines which was offered, last year, by the Committee. Consequently an increased service will be available in 1926.

Interested teachers can secure free copies of the new calendar poster with official dates and topics for this season; also a descriptive folder giving objects and purposes of National Thrift Week, by sending a postal to the National Thrift Committee, 347 Madison Ave., New York City.

National Thrift Week is an economic movement which occurs January 17-23 each year and is based on the following Ten Point Economic Creed.

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In response to a demand from teachers a package of thrift material has been prepared for use in class room teaching of Thrift. The package is available for $1.00 which just covers cost of postage, materials, etc. Order from the Committee at the above address. The materials in this package consist of wall posters, budget books, topics for essay work and portfolio of teachers plans including observance of Franklin's birthday.

PERSONAL NOTE.

Mr. Frank J. Bruce, who has been Head of the Physical Science work in the High School at Chisholm, Minnesota, for the past five years, has recently been appointed by the Central Scientific Company as their field representative for Minnesota and parts of adjacent states. Mr. Bruce is a graduate of De Pauw University at Greencastle, Indiana, and brings to his work, not only an excellent training in science and experience in teaching, but also an unusual acquaintance with the problems of science teaching. Mr. Bruce has served on various committees of both the Minnesota Educational Association and the Northeastern Minnesota Educational Association, and has had a prominent part in the work of the State Committee on the contents of science courses in Minnesota high schools.

SCHOOL NURSES SUCCESSFULLY USED IN MASSACHUSETTS.

Until the advent of the school nurse, health programs in rural Massachusetts were very inadequate. In many towns medical inspection was the only feature, though some towns made provision for oral hygiene. Eighty towns of less than 5,000 population have been conducting dental clinics for one or more years. Some had traveling clinics operating under the auspices of farm bureaus, while others were conducted in cooperation with municipal authorities, nursing associations, or branches of the American Red Cross.

Since the enactment of legislation requiring the employment of school nurses in all towns, improvement has been marked. The nurse helps the school physician with the annual physical examination and makes independent inspection of pupils and buildings. She visits the homes of pupils and confers with parents in regard to health problems. A recent investigation by the State department of education shows that fully 99 per cent of the pupils attending public schools in Massachusetts are receiving the benefit of school-nursing service.

BOOKS RECEIVED.

Nations as Neighbors by Leonard O. Packard, Teachers College, City of Boston and Charles P. Sinnott, State Normal School, Bridgewater, Massachusetts. Pages xii+579. 16.50x24 cm. Paper, 1925. The Macmillan Co., New York City.

United States Official Postal Guide by The Department. 1015 Pages. 16x24 cm. Cloth, 1925. Price $1.25. Government Printing Office, Washington, D. C.

Elementary Psychology by Arthur I. Gates, Teachers College, Columbia University. Pages xiv+594. 13.50x20.50 cm. Cloth, 1925. The Macmillan Company, New York City.

The Choice of a College by W. Comfort, President of Haverford College. Pages vii+55. 10x16.50 cm. Cloth, 1925. The Mamcillan Company, New York City.

Business Law by Alfred W. Bays, Northwestern University. Pages xxvii+473. 13.50x19 cm. Cloth, 1925. The Macmillan Company, New York City.

Elementary Algebra by Arthur Schultze, New York University. Revised by William Breackenbridge, Stuyvesant High School, New York City. Pages viii+334. 13x19 cm. Cloth, 1925. The Macmillan Company, New York City.

Elementary and Intermediate Algebra by Arthur Schultze, New York University. Revised by William Breackenbridge, Stuyvesant High School, New York City. Pages x+461 13x19 cm. Cloth, 1925. The Macmillan Co., New York City.

A Graphic Table by Adren L. Lacroyx and Charles L. Ragot. 18x25 cm. Cloth, 1925. The Macmillan Co., New York City.

Beginners' Geometry by Rolland A. Smith, High School, Newtonville, Massachusetts. Pages xiii+327. 13.50x19 cm. Cloth, 1925. The Macmillan Company, New York City.

General High School Mathematics, Book 1 by David Eugene Smith, Teachers College, Columbia University, and John A. Foberg, Department of Public Instruction, Pennsylvania, and William D. Reeve, Teachers College, Columbia University. Pages viii+472. 14x19 cm. Paper, 1925. Price $1.60. Ginn & Company.

The First Year of Science by John C. Hessler, Knox College. Revised Edition. Pages 9+476. 14x19.50 cm. Cloth, 1925. Benjamin H. Sanborn & Company, Chicago.

Electrical Engineering by Clarence V. Christie, McGill University of Montreal. Pages xxi+613. 15x24 cm. Cloth, 1925. Price $3.00. McGraw-Hill Book Company, 370 7th Ave., New York City.

Mechanical Investigations of Leonardo Da Vinci by Ivor B. Hart, University of London. Pages vii+240. 15.50x23 cm Cloth, 1925. Price $4.00. Open Court Publishing Company, Chicago.

A Geometry of Rene Descartes. Translated from the Latin and French by David Eugene Smith and Marshall Latham, Columbia University. Pages xiii+246. 17.50x23.50 cm. Paper, 1925. Price $4.00. Open Court Publishing Company, Chicago.

A Text Book of Modern Physics by Leroy D. Weld, Coe College, and Frederick Palmer, Jr., Haverford College. Pages xi+737. 15.50x22 cm. Cloth, 1925. P. Blakiston's Son & Company, Philadelphia.

Teaching Science in the Schools by Elliot R. Downing, University of Chicago. Pages xiii+183. 14x20 cm. Cloth, 1925. University of Chicago Press.

Biological Equipment by Cambridge Botanical Supply Company. 158 Pages. Paper, 1925. Botanical Supply Company, Waverley, Massachusetts.

Junior Mathematics, Book 2 by Ernest R. Breslich, University High School, University of Chicago. Pages x+264. 13x19 cm. Cloth, 1925. MacMillan Company, New York City.

BOOK REVIEWS.

Physics for Technical Schools from Colleges and Universities by William B. Anderson, Oregon State College. Pages xxxiii+827. 16x23.50 cm. Cloth, 1925. Price, $4.00. McGraw-Hill Book Company, 370 7th Avenue New York City.

This is a monumental work and is thoroughly modern in all of its aspects. It is a book that any college or university instructor can use in his classes with profit and at the same time, is a work which a Secondary school teacher should use as a reference in his work. It is too heavy for Secondary School class work.

There are many new features in the book, but in general it is a resume or restatement of the known facts in Physics. There are three hundred seventy-three cuts, most of which are made primarily for use in this volume. The diction is splendid. Major paragraphs all begin with bold-faced type.

At the end of each chapter is a list of problems appertaining to the work discussed in that chapter. There is a splendid index so that points mentioned in the book may be easily located. The order of topics consists of mechanics, properties of matter, heat, sound, light, electricity and magnetism. It is a book that should be in the hands of every teacher of Physics both in the university and secondary school. C. H. S.

Problems in Home Economics Teaching by Leona F. Bowman, University of Chicago. Pages viii+146. 14.50x21.50 cm. Cloth, 1925. University of Chicago Press.

This is a thoroughly modern work on this particular subject. It consists of sixty-seven problems that have been selected with much thought and study. These problems are given on the left page of the book. The right side being left blank for notes bearing upon the subject of the problem on the opposite page.

The book is divided into fifteen chapters or parts with problems in each chapter of a kindred nature. Each problem closes with a list of references to points discussed in those problems.

The book is well written and demands a wide circulation, and is one that all home economics teachers should possess. C. H. S.

New Essentials of Business Arithmetic and New Complete Arithmetic by George H. Van Tuyl, Evander Child's High School, New York City. Pages xii+302. 14x20.5 cm., and xxiv+440. 1925. American Book Co., New York City.

Recently a copy of Van Tuyl's "New Complete Business Arithmetic" came to my desk. The book has been examined with much interest.

Upon analysis of the contents of the text, the *newness* is revealed by the novel presentation of fundamentals and essentials connected with this branch of mathematics.

The *completeness* of the volume is revealed in the author's treatment of every phase of arithmetical computation in current industrial life.

The term *business* supports the title of the text by the straight-forward manner in which all subject matter is given to the student in training for efficient service. The author's shorter course, "New Essentials of Business Arithmetic" is equally meritorious.

After an extensive experience, applying arithmetical principles in the practice of higher accountancy, my conviction is that every student of Commerce and Administration should master such a text, and keep it within arm's reach of a future desk. H. F. K.

"An Open Letter to A College Freshman" is the title of a little pamphlet gotten out by that past master of college teaching, Carl E. Seashore of the University of Iowa.

It is primarily a little pamphlet which will inform the first year student in college work exactly what he should do in all phases of his college life, and if he follows faithfully the suggestions made by Dr. Seashore, he cannot help but be successful in his college course.

It is a good book without question. They sell for $40.00 a thousand, $5.00 a hundred and $0.05 a copy. Address The Bureau of Educational Research, State University of Iowa, Iowa City, Iowa. C. H. S.

An Introduction to Economic Geography by Wellington D. Jones and Derwent S. Whittlesley. 37 chapters and 275 pages. Maps, diagrams illustrations and index. University of Chicago Press, Chicago, 1925 $5.00. 6½x9½ inches.

An economic geography in two volumes of which the above is the first. The book is complete is texual materials, class exercises and illustrations and is planned to provide students with stimulating materials that illustrate geographic problems.

In the chapter entitled "Scopes of Economic Geography," the authors state the basic principles of economic geography. "The peculiar contributions of economic geography is an understanding of the relations between natural environment and economic life in the various regions of the earth."

Other chapters relate to the surface, bedrock and mineral deposits, ground and surface water and oceans. Each have sections of clearly organized material well adapted for teaching purposes.

The book has its pictures, graphs, charts and maps separate from the text matter. The photographs are excellent illustrations of geographical ideas from many fields and are an addition to the text matter. Each section of work has a series of questions which compel the student to use definitely the subject matter, the illustrations, the statistics, diagrams and other materials. The introduction outlines the methods used by the authors.

It is a book to be highly recommended for use in colleges or normal schools and for teachers of commercial geography. W. M. G.

Essentials of Algebra. Book Two, by David Eugene Smith, Professor of Mathematics, Teachers' College, Columbia University, and William David Reeve, Associate Professor of Mathematics, Teachers' College, Columbia University. Pages viii+274. 14x19.5 cm. 1925. Price, $1.24. Ginn & Co.

This book is designed for a course in intermediate algebra usually given in the tenth or eleventh school year. For the benefit of students who have not had the good fortune of studying a ninth grade algebra of the more modern type an introductory chapter on algebraic functions is offered.

In general, the topics included in this book are those that are found in the standard courses.

They are treated in modern style. That is to say, the material and problems are so chosen and organized as to make the student feel that algebra is a living thing, which may be applied to the problems of science, engineering and business. J. M. K.

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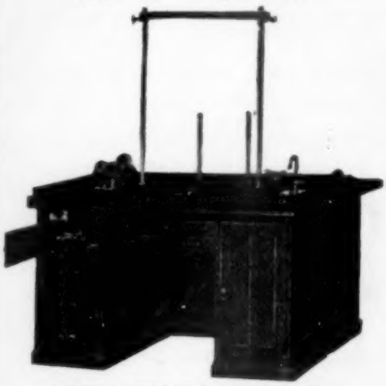

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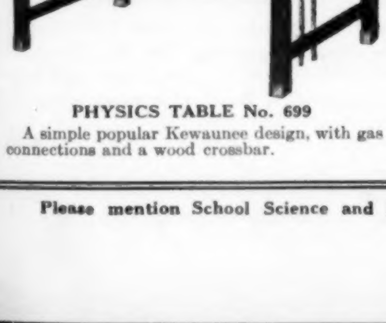

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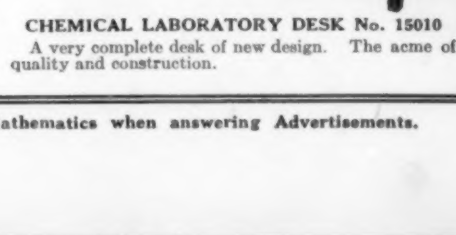

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Solid Geometry by John W. Young, Professor of Mathematics in Dartmouth College, and Albert J. Schwarty, Instructor in Mathematics in the Grover Cleveland High School, St. Louis, Mo. Pages xvi+399. 13.5x19.5 cm. 1925. $1.20. Henry Holt & Company.

This is an attractively written book, with a reduction in the number of text theorems and an addition of a large number of interesting concrete and applied problems. The proofs to many of the theorems are left incomplete.

The authors claim that the exercises are graded carefully as to difficulty so that the needs of the inferior mediocre, and brilliant students are provided for.

J. M. K.

New First Course in Algebra by Herbert E. Hawkes, Professor of Mathematics in Columbia University, William A. Luby, Head of the Department of Mathematics in the Junior College of Kansas City, and Frank C. Tonton, Professor of Education in the University of Southern California. Pages ix+361. 14x19 cm. 1925. $1.24. Ginn & Co.

In this book the authors have aimed to keep the features of this their revised First Course in Algebra which made it such a popular text. They have made such changes in arrangement, in material, and in treatment as experience has shown desirable.

Thus, oral exercises and the meaning of the formula have been stressed. A supplementary chapter on the trigonometric ratios has been added.

J. M. K.

Solving Geometric Originals by Frank Charles Tonton, Ph.D., Professor of Education, University of Southern California. Pages viii+114. 15.5x23.5 cm. Published by Teachers' College, Columbia University, New York City.

This book is the result of a study based on approximately 2,800 examination papers written by New York high school pupils in the New York Regents' Examination in Plane Geometry of June 20, 1918.

The scope of this study is limited to the following considerations:

1. The difficulties inherent in the several exercises of the examination.
2. The differences between boys and girls in their choice of certain exercises for solution and in the abilities shown in the solution of those exercises which they select.
3. The success of the pupil in solving originals, as conditioned by his adherence or lack of adherence to an orderly procedure in thinking.
4. Some changes in the teaching methods employed as essential in securing better results from the teaching of plane geometry.

This study evidently required an immense amount of time and labor on the part of the author and his assistants. It is a real contribution to the teaching of geometry.

J. M. K.

Problems in Elementary Algebra by Mona Dell Taylor, Department of Mathematics, Scott High School, Toledo, Ohio. Pages v+153. 14x19 cm. 1925. Lyons & Carnahan, Chicago.

This is a revision of "Practice Problems in Algebra." In this revision the suggestions of the National Committee on Mathematical Requirements and the report of the College Entrance Examination Board have been followed.

J. M. K.

Plane and Spherical Trigonometry by C. I. Palmer, Associate Professor of Mathematics, Armour Institute of Technology, and C. W. Leigh, Associate Professor of Mechanics, Armour Institute. Pages xiv+221+136. 16x23.5 cm. Price, $2.50. McGraw-Hill Book Company, Inc., New York. 1925.

In this edition much of the text has been rewritten. The exercises with the exception of some of the practical problems are new and much more numerous and have been carefully graded. J. M. K.

The Choice of a College by W. Comfort, President of Haverford College. Pages viii+55. 10x16.50 cm. Cloth, 1925. The Macmillan Company, New York City.

This is a splendid little book which ought to be read by every parent who is contemplating sending son or daughter to college and it ought to be read by every young lady who expects to enter college, as it will give every one interested a phase of college life which is not found in any college registrar.

It is written by a man who is thoroughly conversant with all kinds of colleges. The book touches upon phases of the college with which parents ought to be familiar. C. H. S.

Teaching Science in the Schools by Elliot R. Downing, University of Chicago. Pages xiii+185. 14x20 cm. Cloth, 1925. University of Chicago Press.

This is one of the best books of the kind that has come to the reviewer's attention. It has become as much a science to select subject matter for a book as it is to treat those subjects clearly and scientifically.

One attempting to teach this book cannot help but present the matter in a truly scientific manner, and the book emphasises the fact that scientific teaching is the all important method in this day and age.

There are ten chapters in the book and it is not so large but what a teacher can make use of every page. It is printed in clear ten-point type. There are numerous texts on science mentioned throughout the book. These are valuable.

It is a book which should be in the hands of every person who desires to advance in the scientific methods of teaching science. A faithful study of this book cannot help but create within the student a desire to do the scientific work with utmost accuracy. C. H. S.

Plane Geometry by John O. Pyle, A. M., Teacher of Mathematics in the Carter H. Harrison Technical High School, Chicago. Preliminary Edition. P. Blakiston's Son & Co., Philadelphia.

The author of this book takes the point of view that geometry is one of the natural sciences. "The student of geometry is merely exploring and learning the facts and laws of a particular aspect of objective nature."

This point of view leads to the conclusion that geometry should be given as laboratory treatment.

The author is one of the pioneers who is trying to present geometry to the child on the basis of the child's experiences and his way of thinking. J. M. K.

The Teaching of Elementary Algebra by Paul Ligda, Instructor in Mathematics, McClymond's High School, Oakland, California, with an Introduction by John Wesley Young, Professor of Mathematics, Dartmouth College. Pages xvii+256. 13.5x19 cm. 1925. $1.90. Houghton Mifflin Co.

The reviewer had the pleasure recently (May, 1925) of calling the attention of mathematics teachers to a book by H. C. Barber on the Teaching of Junior High School Mathematics which reflected the new movement in the teaching of elementary mathematics.

He is again pleased to call attention to this book by Mr. Ligda, which points out the reasons why elementary algebra in the traditional form has been so unsatisfactory. It gives analysis of these reasons and

proposes remedies which are worthy of the consideration of all mathematics teachers.

The chapters on the use of the function concept in the solution of problems and problem analysis are especially interesting. J. M. K.

Statistical Methods by Frederick Cecil Mills, Associate Professor of Business Statistics, Columbia University. Pages xvi+604. 15x22 cm. 1924. $3.60. Henry Holt & Co.

"The day when intuition was the chief basis of business judgment and unsupported hypothesis the mode in social studies seems to have passed. Following the lead of workers in the older and traditionally more accurate physical sciences, social scientists and serious students of business are employing in greater measure than ever before a method of study based upon the observation and analysis of facts."

Teachers who are looking for applications of mathematics to common problems of economics and business should read this book.

Introduction of Algebra Into American Schools in the Eighteenth Century by Lao Genevra Simons. Published by Bureau of Education, Department of the Interior. Bulletin, 1924, No. 18. 15 cents. Pages 78.

This bulletin furnishes interesting material on the teaching of algebra during the eighteenth century. J. M. K.

Analytic Geometry and Calculus by B. H. Crenshaw, M. E., Head of the Department of Mathematics, Alabama Polytechnic Institute, and C. D. Killebrew, M. S., Professor of Mathematics, Alabama Polytechnic Institute. Pages x+222. 16x24 cm. 1925. Price, $2.75. P. Blakiston's Son & Co., Philadelphia.

The authors of this book have outlined a course in analytic geometry and calculus for engineering students who have but two years of their course devoted to mathematics. They have therefore sought to cut out non-essentials and duplications.

The differential calculus is introduced before the discussion of tangents and normals. J. M. K.

The First Year of Science by John C. Hessler, Knox College, Galesburg, Illinois. Pages xi+576. 14x19 cm. Cloth, 1925. Benjamin H. Sanborn & Co., Chicago.

This is an extraordinary good book on General Science. It is a complete revision of the older book. The subject matter is accurate in its presentation.

It makes interesting reading for the ordinary mature layman and a freshman class in High School using this book as a text will have no difficulty in understanding it.

It is printed in ten-point type on uncalendered paper and the main points in every paragraph are printed in bold-faced type. Practical problems are presented throughout the book.

Boards of Education in the market for a General Science text cannot better themselves than by selecting this text for their schools. There are three hundred thirty excellent cuts and half-tones scattered throughout the book. These all being selected for the principles which they are to illustrate. C. H. S.

Biological Equipment, Catalog 91 by Cambridge Botanical Supply Company. 158 Pages. 15.50x23 cm. Paper, 1925. Cambridge Botanical Supply Company, Waverley, Massachusetts.

There has recently come to our desk this splendid catalog of laboratory apparatus. Many new features are incorporated in the book, especially

Back numbers of School Science, School Mathematics, and School Science and Mathematics may be held for 35 cents a single. The Mathematical Supplements for 20 cents a copy. In sets, the prices are, postpaid:

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those for maintaining an aquarium, and those in which micro-projectors are given an important place. Something new here, which instructors will be interested in knowing about.

The microscopical preparations are splendid. The descriptions of them par excellence. The lists of slides being one of the best in existence. The equipment for High School Biology course is splendid, and will save instructors much time and expense if they should select the equipment as printed in this catalog for the one to be used in their laboratory.

All Physics and Botanical teachers should possess a copy of this book. Send for it. C. H. S.

Modern Physics by Leroy D. Weld, Coe College and Frederick Palmer, Haverford College. Pages xi+737. 15x22 cm. Cloth, 1925. P. Blackiston's Son & Co., Philadelphia, Pa.

The plan of this book is excellent. It has been written in such a manner as to make the subject popular and yet, at the same time, not in any way making the subject matter cheap. The fundamentals of the subject are presented in a clear, concise and interesting manner, and in such a form of language that the average student can understand the text without any additional explanation.

Emphasis has been put upon the physical conception of the matter discussed rather than upon the mathematical presentation of the phenomena involved. The wave method rather than the ray method has been adopted when discussing the lenses and mirrors.

The book is divided into twenty-two chapters and is printed in ten-point type, major paragraphs beginning in bold-faced type. Each chapter closing with a list of problems bearing upon that chapter. These problems are well and carefully selected. As already suggested, very little mathematics is given. In fact, none but what the ordinary high school pupil might be able to understand.

There are five hundred well selected and well executed drawings and half-tones. There are tables of constants sufficient to meet all the needs of the text. It is well indexed. There being eleven double column pages in this phase of the work.

It is printed on a good quality of paper not too highly calendered, thus making it not too hard to read by glaring reflected light. It is a book that every physics teacher should possess.

C. H. S.

Elementary Psychology by Arthur I. Gates, Teachers' College, Columbia University. Pages xiv+594. 13.50x20.50 cm. Cloth, 1925. The MacMillan Co., New York City.

There has been a demand for a book on Psychology, elementary in its nature, which would discuss topics centering around this topic which would be treated scientifically yet at the same time in a manner that the ordinary lay-reader as well as the general student will be able to understand without very much difficulty. Such a text we find in this book.

On the whole, the main discussion is on the simple facts of Psychology. Being an elementary text with a leaning towards the higher facts of Psychology, there are more or less limitations, but the field as a whole is covered splendidly. It is a book that ought to be in the hands of all secondary teachers of the subject.

The University and College men will be able to secure some adjustment of their new circumstances by a careful study of its contents. The diction is good, facts are reliable, printed on uncalendered paper, bound splendidly and will stand hard use. C. H. S.

Preparation and Use of New-Type Examinations by Donald G. Paterson, University of Minnesota. Pages vi+87. 13.50x19.50 cm. Paper, 1925. Price, 60c. World Book Company, 2126 Prairie Avenue, Chicago.

This book has been prepared for the express purpose of enabling teachers to make use of new types of examinations in place of the old style form of essay examinations, either for monthly tests or for the final examination. It not only will be helpful to college and university instructors but to high school men as well. There is a growing demand for a type of examination which will eliminate very largely this essay form of answer work and reduce the final answers to a minimum. This not only will save time on the part of the examined but it will also save much time on the part of the examiner as he will be very much more inclined to be accurate in his reading a short answer than he would a longer one. This book is an outgrowth of experience in new forms of examinations and is well worth the while of every instructor trying it out. All teachers should get in touch with the author if they believe the form of examination can be improved. C. H. S.

The Early Embryology of the Chick by Bradley M. Patten, Associate Professor of Histology and Embryology, School of Medicine, Western Reserve University. Pages xi+177. 23x155 cm. Cloth, 1925. P. Blakiston's Son & Co., Philadelphia.

The author has made a commendable attempt to outline the essential facts of early chick development without exhausting the subject. The necessity for brevity and clarity in elementary texts is witnessed by the popularity of the outlawed compends among medical students. There are 63 series of figures, most of which are new and the labels of which are direct. The drawings represent every phase of the laboratory work on the chick, and in the hands of the beginner may be very valuable or detrimental, as the student chooses to make them. The type is ten point. The subject heads stand out well, the paper is good quality. The reviewer is very favorably impressed with the book as a text in a beginner's course in general embryology. J. I.

College Chemistry by Lyman C. Newell, Professor of Chemistry, Boston University. 1st edition. Pages vi+645. 15x20.5x4 cm. Cloth, 1925. D. C. Heath & Co.

This new book from the pen of so well known a writer of text books as Lyman C. Newell calls for a careful study on the part of every teacher of general chemistry in our colleges. On first glance it becomes apparent that Professor Newell has put much time and thought on the newer phases of general chemistry and a study of the parts of chapters dealing with such topics as colloid chemistry, atomic structure, and radioactivity, shows that he has taught these subjects with the skill of the master teacher. His method is to teach some of the fundamental outlines of a subject and then to refer to it and apply it to case after case in later portions of the book. The chapter on Chemical Equilibrium especially commands the admiration of the reviewer.

One of the outstanding features of the book is the use of a large number of photographs of distinguished chemists, many of them being reproduced from originals in the possession of the author. There are also many excellent pictures of industrial plants and appliances and much condensed industrial chemistry is tucked in between the covers. As was said at first the book should be examined by all college teachers of general chemistry. F. B W.

CONTENTS *for* DECEMBER, 1925

No Numbers Published for
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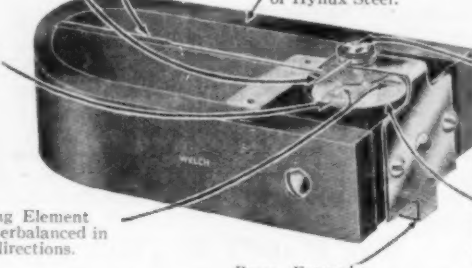

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